PENNSYLVANIA STATE RAILROAD COMMISSION

IN THE MATTER OF THE COMPLAINTS AGAINST

THE PHILADELPHIA RAPID TRANSIT COMPANY

Volume I

REPORT

TO THE COMMISSION BY

Ford, Bacon & Davis.

MARCH 7, 1911

VOLUME I

CONTENTS

SUMMARY OF REPORT

REPORT

VOLUME II

CONTENTS

TABULATED STATEMENTS, MAPS AND DIAGRAMS

PHYSICAL PROPERTY

COMPARATIVE OPERATING STATISTICS OF LARGE AMERICAN STREET RAILWAY SYSTEMS

CAR MAINTENANCE

ACCIDENTS

TRAFFIC AND SERVICE

ROUTING

MAPS AND DIAGRAMS

Existing Routes (Continued)

Suggested Routes

SUMMARY OF REPORT

New York, March 7, 1911.

To the Pennsylvania State Railroad Commission,
Harrisburg, Pennsylvania

SIRS:

On May 27, 1910, you commissioned us to make an examination of the service and equipment of the Philadelphia Rapid Transit Company, in order to determine whether certain complaints which had been made against the service rendered by that corporation were well founded or not, and to make a report to you upon existing conditions with recommendations.

In furtherance of this examination, we first obtained from the Philadelphia Rapid Transit Company, upon forms prepared by us, comprehensive statistics showing the amount and character of the physical property and presenting a record of its operations for a period of years. We also secured from reports of supervisory commissions and street railway companies, recent comparative statistics of the four other largest American cities, New York, Brooklyn, Boston and Chicago. From July 12, 1910 to February 1, 1911, we made systematic observations of the traffic and car service in Philadelphia. We also made a special examination of the car equipment of this Company and of the standard cars of the four other cities. We have tabulated the statistics thus obtained, reducing the problem wherever possible to the basis of figures.

The detailed report herewith presented comprises a series of tabulated statements, maps and diagrams, representing the principal features of the information collected and forming the basis of the general discussion and recommendations in the accompanying text. From this report we present the following summary of our conclusions and recommendations:

It is our opinion that while in many particulars the property and service of the Philadelphia Rapid Transit Company compare favorably with other large systems, there are lacking two essential features of good street railway service, upon which, more largely than any other, depend the comfort and convenience of the traveling public.

While we find the track construction to be substantial, the surface track mileage larger than the average considering the population served, the overhead line of first class design, the power plants of adequate capacity and fair economy and the car barn and shop facilities ample; the car equipment, which is the most important part of the physical property from the passengers' standpoint, is distinctly inferior to that of other large American cities; and while the average seats provided per passenger and total car mileage operated throughout the entire day are greater than the average of other cities, the proportion of rush-hour car service to middle-of-the-day service is considerably

less than standard practice, resulting in unreasonable overcrowding at the times of heaviest traffic. We will, therefore, in this summary, call your attention principally to our criticisms of rush-hour car service and car equipment, leaving minor recommendations for your attention in the detailed report.

RUSH-HOUR CAR SERVICE

Counts of Rush-Hour Traffic

An extended series of observations and passenger counts was made for each line, especially as to operation during the evening or heaviest rush hours in and adjacent to the principal delivery district, which is the central business section bounded by the Delaware River, 17th Street, Cherry and Locust Streets. From these we ascertained the number of passengers on each line during each half hour of the rush hours at the point of maximum loading. We found from our observations and records covering a period of about six months, that the evening rush-hour traffic for Wednesday, October 5, 1910, represented an average for that time of year, and consequently have used in our determinations the count made on that day. We ascertained for each line the number of passengers carried past the point of maximum loading during each half hour and the number of cars observed, and determined the absolute and the average car loading of each line and of each group of lines by sections of the city. Having thus obtained the number of passengers by half hours from 4 to 7 P. M. carried past the maximum-load point of each line, we were in position to make a critical analysis of the service operated and to devise a plan of car service which would provide adequately for this rush-hour traffic.

Limitations of Rush-Hour Service

This problem involves the determination of a standard of reasonable car service for the rush hours, and the definition of practicable rules for car loading. The extreme limits of such service would be on the one hand, to provide seats for all passengers, and on the other, to continue the midday car service through this busy period. The maximum number of cars which can be operated is absolutely limited by track and crossing capacity and the necessity of providing sufficient employment for the extra car men. The track as now operated in the delivery district of Philadelphia has not yet been used to its greatest capacity except on some streets. An efficient rerouting of lines, the replacement of present small cars by large motor cars and the use of large trailers, if practicable, would make possible a considerable increase of service in this district.

The Company now schedules in winter about 39% more cars, and in summer about 45% more cars, during the evening rush hour, than on its base schedule during the middle of the day. Other large American street railway systems operate as many as 100% more cars during the rush hours than on the base schedule, which proves the feasibility of at least doubling the service during the rush hours with single car operation. With the use of large trailers it is believed that a still larger proportion of rush-hour capacity would be found practicable.

On the other hand, however, there are conditions of finance in the broad sense which place an economic limit upon the amount of car service that can be operated at this time of day. Track and street capacity must also be conserved as far as possible, in the interest of speed of operation.

Reasonable Car Loading

Looking at the problem from another standpoint, if the service is proportioned upon the number that the car can accommodate comfortably, both seated and standing, its capacity would be used most efficiently and overcrowding would be prevented.

From careful studies of car capacities, we have found that four square feet of aisle and platform space per standing passenger allows comfortable standing space. This would mean, for the Philadelphia Pay-Within car, two rows of standing passengers with sufficient space for passage between, and a total capacity of 76, of whom 38 would be seated and 38 standing. In other words, for a car with longitudinal or lengthwise seats, the standing capacity would equal the seating capacity. For a cross-seat car like those now operated in Philadelphia with seating capacity of 40, the standing capacity would be 29 and the total 69. If the usual large prepayment platforms are used on the cross-sêat car it would accommodate 36 standing passengers or with the seated passengers a total of 76. Therefore, applying this rule to the cross-seat car, the standing capacity would equal from 60% to 90% of the seating capacity. This standing load is practically within the limits used by other American street railway companies which have given attention to the subject, and as prescribed in some cases by governmental regulations abroad.

We believe this to be a reasonable limit of car loading, and have used it in our calculations and recommendations of rush-hour service.

Limits to Individual Car Loads

In order to prevent or lessen periodical overcrowding caused by the bunching of cars or passengers, we believe it is necessary to limit the loading of cars to the standard capacity determined. This under ordinary conditions of operation can be accomplished with platform doors or gates which close the entrance and exit when the car is in motion, together with the use of the "car full" sign.

The reasonable use of the individual car limit and the "car full" sign has been found beneficial by the American companies that have adopted it. This largely does away with the uncomfortable, unsanitary overcrowding, so common at present in many American cities at rush hours, and facilitates the speed and regularity of operation by eliminating the most serious cause of bunching of cars. Such a definite notice also reduces the annoyance of being passed by the motorman.

Efforts to restrict car loading to standards sometimes used abroad have met with objection because the limit has been placed at or near the seating capacity. This is impracticable under American conditions. During the non-rush hours, however, seats should be provided for all passengers. As the traffic increases at the beginning of the rush hours sufficient cars to furnish seats should be added until the maximum schedule is in operation.

Recommended Rush-Hour Service

We therefore recommend that the Philadelphia Rapid Transit Company should furnish sufficient rush-hour car service to provide the above standard capacity, and should limit individual car loads on a practicable plan, making allowance for extraordinary conditions.

Improved Service Practicable Immediately

As the present rush-hour service is considerably less than the standard recommended, this plan cannot be put into effect until additional cars and power are secured.

During the time of construction of this equipment we recommend that the Company operate a service, as far as the number of present cars and the capacity of its power system will permit, which will provide on each line during the busiest half-hour an *average* car loading equal to the recommended standard of maximum car capacity. This standard of service immediately practicable would require the operation of 1,987 cars, an increase of 315, or 19% over the winter schedule, and of 205 cars, or 11% over the summer schedule. Although this would result in a considerable improvement of car loading there would still be carried regularly maximum loads up to the crowding limit of the car.

Recommended Service Applied to Traffic of October, 1910

From a large number of observations both in Philadelphia and elsewhere, we find that the maximum car loads on any line in a half-hour approximate 25% more than the *average* loading for that half-hour. Thus for example, if 76 is fixed as the maximum load of the Pay-Within car, the *average* loading for the heaviest half hour would be 61 passengers. Consequently, our recommendation for standard service would require approximately 25% more cars to pass the maximum point of loading on each line at the busiest half-hour than would be required for the *average* loading just referred to, and this as calculated for the entire system would result in an additional number of large cars in operation of about 14%.

In order to ascertain whether our recommended standard limit of rush-hour car loading would be unreasonable or impracticable in Philadelphia, we have calculated in detail for each line the car service which would have been necessary to provide for the rush-hour traffic of an average day of October, 1910, represented by Wednesday, October 5th. We have assumed that additional small single-truck and maximum-traction cars would be used to furnish the increase of service of lines on which these types are now operated, which would mean that practically all of the best of this class of car equipment now on hand would be used. The additional cars necessary to provide the recommended service are assumed to be motor cars having the same maximum capacity of 76 as the present Pay-Within car.

With the use of these types and of the present large double-truck cars, there would be required to provide the recommended service, a total of 2,265 cars in operation, rendering necessary the purchase of 489 cars. This total number of 2,265 cars required for recommended service, compares with 1,672 called for by the Company's winter schedule, an increase of 593 cars, or 35%. Compared with the Company's summer schedule, which calls for 1,782 cars, it represents an

increase of 483, or 27%. This increase would differ for each line, in some cases being more and in some less than this average. The increase of cars on lines operating into the delivery district is from 1,315 cars of present winter schedule to 1,801 cars, or 37%, thus necessitating some rearrangement of routing for certain of these lines.

If 2,265 cars are operated at the rush hours, there would be 89% more cars in service than in the middle of the day on the base schedule in force last October. This is within the limits of American practice.

We estimate that this service for both morning and evening rush hours would result in additional car mileage of 11%, or an increase of approximately 9% in operating expenses. We believe that more efficient scheduling during the non-rush hours and the use for all day service of the large new cars purchased to replace many of the small single-truck cars, together with the saving which might be secured by a comprehensive rerouting plan, would largely offset the additional expense of operation at the rush hours. Thus, while providing far better service to the public, the Company's operations might be placed on a more provident basis and a considerable increase in gross earnings made possible.

Rush-Hour Service on Subway-Elevated Division

With regard to the subway-elevated service, we also find, especially during winter operation, a condition of overcrowding. We would recommend that additional service be provided on the basis outlined for surface cars. To accommodate the traffic on October 5, 1910, in accordance with this standard, 120 cars would have been required. On this division, 10% of the cars in operation are needed as a "shop" reserve, or as of that date, 12 cars were required in addition to the 120 cars now owned.

Future Car Service

The number of additional cars stated above to be required for both surface and subway-elevated operation should be considered as examples of the rules recommended, not as present requirements. They were the number necessary in October, 1910. The traffic is continually increasing and with the broader plans which have been proposed, the rate of increase should be more rapid in the future. The car equipment calculated to have been necessary for last October with the additional power equipment, would require probably a year to purchase and install, and by that time, still more cars and power will be needed. Consequently these standards of car loading and car service should be adopted in principle, and should be applied by a bureau or department to be established by the Company. Based on the periodical determinations of this department, the Company should estimate and provide for its car and power requirements from one to two years in advance.

CAR EQUIPMENT

Present Type of Cars

The other principal criticism to which we have referred, concerns the inferior character of the car equipment. Of the 3,292 cars owned by the Company about two-thirds are of the small, single-truck type purchased at the time of original electrification, and of the large double-truck cars, 272 were reconstructed from the small cars by splicing in

a short section without modernizing this equipment; consequently about 70% of the total cars are of a type generally unsuited to present conditions of congested traffic. Of the remaining 772 large double-truck cars, about 90% have been rebuilt and changed from cross-seat cars into the present longitudinal-seat Pay-Within type. This conversion, largely on account of the change to longitudinal seats of poor design, has rendered this car uncomfortable and unpopular, especially for summer operation.

Of the total surface car equipment in Philadelphia, 36% are large double-truck cars, in New York 75%, in Brooklyn 89% and in Chicago about 75%. While the single-truck car has its use on lines of light regular traffic, it is generally unsuitable for operation during the rush hours in the congested delivery district of large cities, and on many lines it is uneconomical to operate. It is assumed that the Company will desire gradually to replace a considerable proportion of these single-truck cars by the purchase of large cars. We do not make any definite recommendations upon this point, as it concerns principally the operating economy.

Comparative Car Purchases

Reasonable service during the rush hours, as stated above, would necessitate, as of last October, the addition of 489 large cars. With the purchase of these cars, the proportion of large double-truck cars owned to total closed and semi-convertible cars would be about 63% or more nearly the proportion in other cities.

In this connection it is of interest to note that during the past ten years the Philadelphia system purchased 655 large double-truck surface cars, while the two large surface systems of New York City purchased 1,472 cars, the Brooklyn systems 1,127 cars and the Chicago systems about 2,200 cars. These figures do not include the large amount of subway and elevated equipment purchased in the other cities, nor does the figure for the Philadelphia company include its 120 subway-elevated cars.

We have made a detailed examination of the principal types of the present Philadelphia cars, especially as to points affecting the public comfort and convenience. We have made similar examinations of the standard cars of the four other large cities, all of which are fully described in the detailed report.

The Philadelphia Pay-Within Car

Regarding the principal points of design of the Philadelphia standard car our conclusions and recommendations are as follows:

The principal criticism of this car is the replacement of cross seats by longitudinal seats. This was occasioned by the retention of the small platforms, which with the adoption of the prepayment plan compelled the exit of passengers from the front platform only, requiring a wider aisle than was practicable with the double row of cross seats. The sliding platform doors necessitate door pockets which interfere materially with the comfort of passengers on the corner seats and narrow the car entrance. It is not believed, however, that this difficulty can be much improved without practically rebuilding the ends of the car and the platforms. Eight cross seats should be restored in this car, either half on each side or all on one side. The cars already

altered by the Company, on the former plan, are understood to operate satisfactorily. With car loads limited as recommended the passageway is ample. The remaining longitudinal seats should be remodeled by using a more comfortable, higher back of spring rattan and by proper sloping of seats and backs.

The sliding platform doors operated by air should be provided with a simple positive mechanical release so that they can be opened by passengers in case of emergency. This device should be under the proper restriction of motorman or conductor.

These cars are also insufficiently provided with steadying devices, which causes an unusual number of accidents by passengers falling on cars. Suitable grab-handles on the backs of the proposed cross seats, and grab-handles, horizontal rails or stanchions on platforms should be provided, to reduce this risk.

The number and capacity of the electric heaters on this car should be doubled in order to secure the heating effect of the small single-truck Philadelphia car, and the usual heating effect of standard cars of other cities.

The present number of lights should be doubled in order to provide the amount of lighting usual in modern standard cars of this size.

Both the line and destination signs are of poor design and insufficiently illuminated. Transparent line signs should be used on the front, rear and sides of the monitor and illuminated from the car. A destination sign should be placed in the center of the front and rear vestibules directly under the hood, independently illuminated.

This car should be provided with the usual mechanical sander so that the motorman can drop sand on the track when necessary for an emergency stop.

The present projecting fenders should be used only on high speed lines in the suburban districts and when thus used should be properly maintained. Automatic wheel guards should be installed for city service in place of the projecting fender. These are placed under the car platform in front of the wheels and operate automatically when the trip strikes an obstruction. They have been found to be of value in the reduction of fatal accidents, where used in other cities. Persons struck constitute a large class of fatal accidents occurring in Philadelphia. With the use of these wheel guards it is advisable to change the design of draw-head so that it will not project beyond the bumper.

Other Surface Cars

As a large proportion of the other types of surface cars will, it is assumed, be discarded within a few years, it is believed not to be desirable to reconstruct them except for the requirements of safety. We would recommend that all surface cars be equipped with mechanical sanders, automatic wheel guards and non-projecting draw-heads, and that projecting fenders be used only on high-speed lines in the suburbs.

All cars not painted within the past year should be put through the paint shop, and thereafter painted and varnished on a definite schedule.

We recommend that the system and nomenclature of line and destination signs be entirely rearranged and standardized.

Subway-Elevated Cars

The present subway-elevated cars are of good design and no changes are recommended.

New Standard Surface Car

It is assumed that the new standard car for Philadelphia will be a two-motor, prepayment car with windows capable of large opening, which would make it suitable for both summer and winter operation. If the body is 28 feet long with platforms 5′ 6″ long (inside), mounted on reversed, center-bearing, maximum-traction trucks, the overhang of car without projecting fender when operated on the standard track curve at 50-foot street intersections would be approximately the same as the bumper on the present Pay-Within car, and about 18 inches less than the overhang of the fender on the present car. Consequently the length of body might be 30 feet if found desirable, or even longer if operated on some lines. For the purposes of this report we have assumed the use of a 28-foot cross-seat car as generally practicable, with seating and standing capacity of 76 passengers on the basis recommended.

This, with a car 8′ 4″ wide with skeleton sides and 34-inch seats, would permit of an aisle 28 inches wide. With exits from both rear and front platforms, and with the recommended limit of car load, this width of aisle should be found practicable from an operating standpoint.

Our recommendations upon the points of design especially affecting the traveling public, are as follows:

The illuminated line and destination signs should be of the same type as recommended for the Pay-Within car.

The height of the step should be from 14 to 15 inches and the width of step at least 11 inches. The step should be folding or protected and should have safety tread.

The folding platform doors should be mechanically operated by motorman or conductor and should be kept closed while the car is in motion. The bulkheads should be open and all passageways should be at least 23 inches in the clear. The conductor should be located on the rear platform behind a suitable rail or steadying device.

The seats and backs should be of spring rattan, of comfortable height and properly sloped.

The vestibule windows should be given full opening. Monitors should be fixed shut and there should be provided sufficient roof or monitor automatic ventilators.

There should be installed 16 electric heaters of a total rated capacity of 12 amperes.

Twenty 16 candle power incandescent lamps should be used; 15 inside the car arranged in single sockets on the ceiling and lower decks, 1 on each platform, 2 for destination signs and 1 for headlight.

There should be a passengers' push-button signal on each side post of car with electric bell or buzzer on platforms.

Mechanical sanders and automatic wheel guards should be installed. Draw-heads should not project beyond bumpers.

Estimated Cost of Additional Equipment

The addition of 489 cars, if all motor cars of the above standard, would involve an expenditure for car equipment and equivalent additional capacity of power house and feeder system, car houses and shops which we estimate at approximately $7,126,000. The recommended changes in present Pay-Within and other surface car equipment are

estimated to cost not more than $500,000. Twelve additional cars for the subway-elevated line would cost about $144,000. These recommendations, therefore, involve a total expenditure to secure the recommended car capacity needed in October, 1910, of approximately $7,770,000, and are exclusive of betterments and extensions of track and line. With a normal rate of growth we estimate that at least 100 additional cars per year, with power and storage capacity, will be needed to provide for additional traffic.

REROUTING PLAN

We find that the present routing of cars in Philadelphia is poorly arranged both from standpoints of public convenience and economical operation. The delivery district trackage is not accessible to lines from all sections of the city. Lines through the residence districts are not spaced uniformly, and many lines were located originally under competitive conditions on narrow streets, with numerous curves and frequently crossing each other. We submit in the detailed report, a statement of the general principles involved, and have therein developed a tentative plan of rerouting covering the entire city, based on these principles and upon the information derived from observations and passenger counts. This plan is suggested as an approach to the subject, and is presented for discussion and study. A final plan of rerouting should be adopted by agreement of all parties interested and should be put into effect as soon as practicable.

We would refer you to the detailed report for information regarding physical property, car maintenance, accidents, regularity of schedules and comparisons with street railway systems of other large cities.

FORD, BACON & DAVIS.

REPORT

PHILADELPHIA RAPID TRANSIT COMPANY

The information compiled from statistics furnished by the Company and from reports of supervisory commissions and street railway companies of other large cities, and developed from the observations made by this firm upon service and equipment in Philadelphia and other cities has been prepared in the form of tabulated statements, maps and diagrams which are presented in Volume II of this report. These statements are described and commented upon below under the following headings:

Physical Property
Surface Cars
Subway-Elevated Cars
Recommendations as to Cars
Operating Statistics
Comparative Operating Statistics of large American Street Railway Systems
Car Maintenance
Accidents
Traffic and Service
Routing

The tabulated statements of Volume II are arranged under the same headings.

The maps and diagrams in Volume II have been prepared to show the following information:

Location of Tracks and Buildings
Traffic Points and Districts
Traffic
Existing Routes
Suggested Routes

This information was secured during the period from June 1, 1910, to February 1, 1911, so that the date of this report may be considered as February 1, 1911. The statistics of physical property and of operation are principally as of June 30, 1910, or the year ending with that date. The observations of traffic and service are largely of September and October, 1910.

PHYSICAL PROPERTY

For the purpose of this report blank forms were submitted to the Philadelphia Rapid Transit Company upon which complete details of its physical property covering quantities and types of construction were obtained. General inspection, only, was made as to condition of the property except in the case of passenger cars.

The statistics furnished by the Company have been examined and compiled, and are presented in Volume II as tabulated statements of which the following is a summary.

Rail

When the street railway system in Philadelphia was reconstructed for operation by electricity, the city prescribed the use of a 9-inch high rail section with flat tram weighing 90 pounds per yard. In the present trackage this rail constitutes 50 per cent. or 289.43 miles, two-thirds of which was laid prior to 1899. In 1903 The Union Traction Company adopted a 9-inch section with Metropolitan type tram weighing 141 pounds per yard. This has since been used almost exclusively in paved streets and now constitutes 35 per cent. of the total track. Of the 586.4 miles of track used in operation, 90 per cent. is laid with rail weighing 90 pounds per yard or more; 42 per cent. is of about fourteen years average age, and the remaining 58 per cent. averages about five years old. In weight of rail and average age the track in Philadelphia is superior to that in other large American cities, except Chicago where the track system has been largely reconstructed in the last four years. The desirability of using a rail as heavy as 141 pounds per yard may be questioned, in view of the development of light weight cars. The track on Market Street east of the Schuylkill River and on all north and south streets, from Callowhill to Walnut, is laid in concrete. With this exception, practically all track in Philadelphia is laid without foundation or ballast. This results generally in poor line and surface, but not to an extent to impair seriously the riding qualities of the track. No preservative treatment for ties has been adopted. On the heavy rail an expensive patented joint has been used, with excellent results.

Special Track

There are 1986 special work layouts made up of 4098 parts, each part being a convenient single track unit as described. On account of the wide and uniform distribution of population and of the narrow streets requiring the use of single track, more special work is required than in any other of the large cities. Of this special work about 71 per cent. is of hard steel center or solid manganese construction. Great care has been given to all details of design. Distinct characteristics of the special work in Philadelphia are the large number of single track crossings and the generally short radius curves made necessary by the narrow streets. There are 7.3 parts of layouts per mile of

single track, or 3.5 complete layouts per mile of single track. There are crossings at 888 different locations.

Bridges

The Company operates over 148 bridges and under 86; 165 of these bridges separate the grades of railroads and highway, 66 carry the street railway tracks over water courses and 3 over highways; 140 are steel, 7 wood and 87 masonry. The Philadelphia Rapid Transit Company maintains 49 of these bridges, or about 17 per cent.

Grade Crossings

The tracks of the Philadelphia Rapid Transit Company cross steam railroads at grade at 103 different locations with 339 track intersections, as follows:

	Locations	Track Intersections
Pennsylvania R. R.	44	123
Philadelphia & Reading Ry.	44	181
Baltimore & Ohio R. R.	6	20
Belt Line	9	15

Thirty-six track intersections are on main or passenger lines; 254 intersections on freight lines and 49 on freight spurs. Of the 103 locations, 2 are protected by derails and gates, 1 by derails alone, 33 by gates and 14 by watchmen, leaving 53 unprotected, of which 23 are freight spurs.

Overhead Line

Ninety-one per cent. of the overhead line is span construction, the remainder being principally bracket construction on the suburban lines. The Company owns 35,174 poles, of which 33,310 are round iron, used exclusively in the city, and 1,864 cedar, used on the suburban lines. Sixty per cent. of the trolley wire is 2/0 and forty per cent. 4/0.

Wire and Cables

The transmission and distribution system comprises 120.24 miles of high tension transmission cable (13,200 volts) and 1,111.1 miles of direct current feeder cable, the sizes used principally being:

211,600 c. m.
500,000 "
650,000 "
1,000,000 "

110.13 miles of signal wires and cables are employed; 104.42 miles of telephone cable and 159.51 miles of telephone and target wire. Practically all feeder cables in the city are underground, being laid in 213.72 miles of run of conduit which averages about 11 ducts to the run.

Cars

The subject of car equipment has been made a separate section of this report. In addition to its passenger equipment, the Company owns 410 miscellaneous cars, which includes 86 sweepers, 103 plows, 13 mail cars, 19 express and freight cars, 14 cars for hauling city ashes and 18 cars for power house coal. 364 of these miscellaneous cars are single truck and 46 double truck.

Power

The Company operates 12 power generating plants having total rated capacity as follows:

Boilers	134 units	54,425	B.H.P.
Engines and Turbines	59 "	100,160	H.P.
Generators	59 "	66,775	K.W.

The prime movers comprise 46 reciprocating engines of 53,510 rated H.P. and 13 steam turbines of 46,650 rated H.P. Of the generator capacity 31,000 K. W. is alternating current and 35,775 K. W. direct current. The largest plant is the one at Delaware Avenue and Green Street, the new portion of which has a rated generator capacity of 18,000 K.W. and the old portion 5,800 K.W. Three of the twelve power plants have a capacity of less than 1,000 K.W. each. Nine rotary converter sub-stations and five active storage battery sub-stations, having a total 8-hour discharge capacity of 673 K.W.H., are used in connection with the distribution of current. The total generating capacity is sufficient for all ordinary demands of transportation but is not sufficient to supply heat for the cars at the rush hours. The generating plants, with the exception of the new plant on Delaware Avenue, and that at Second and Wyoming Streets, were built by competitive companies in the days of direct current distribution. They are, however, operating with fair economy as compared with other large systems, although not located or equipped to produce power for the entire property with the economy which might be realized from a modern power system.

Car Houses and Yards

The surface cars are operated from eighteen car houses, having a capacity of 2,283 cars. Nine of these car houses were built wholly or partly in horse-car days. Four, having a capacity of 475 cars, were built at or near the time of electrification, and five, having a capacity of 1,009 cars, have been built of modern design, within eight years. Like the power plants, the older car houses were located under conditions now obsolete. To care properly for electric cars in service it is necessary to have suitable car house accommodations in the way of protection from the weather, pit room for inspection, space between tracks for cleaning, ample track facilities for switching, dispatching and classifying cars as they come in or go out. Many of the old barns do not meet these requirements. The car houses built since electrification are generally well designed and well located. Exceptionally good accommodations for the men are provided at all of the larger car houses. There are eight storage car houses accommodating 670 cars and three yards accommodating 200 cars.

Repair Shops

Small and ordinary car repairs are made at the operating car houses where shop space is set aside and the necessary machinery provided. All car work in the nature of construction, including changes in design of present equipment, is performed at a shop maintained for this purpose at 8th and Dauphin Streets. General repairs and overhauling of equipment in service are performed at the central shops at Kensington Avenue and Cumberland Street. A separate shop is maintained for roadway maintenance and repair work, a large part of the special track being manufactured by the Company itself.

Freight Houses

Within the past year the Company has established a system for handling freight and express, particularly to suburban points. For this purpose it has built nine small freight houses in outlying districts and a central freight house at Front and Market Streets.

Right-of-Way

Of the Company's lines 13.45 miles are on private right-of-way, of which the subway-elevated system occupies 0.56; 4.37 miles of this right-of-way is 70 feet in width, 2.18 is 60 feet and the remainder of varying widths from 5 to 50 feet.

Real Estate not Used in Operation

The Company owns 28 parcels of miscellaneous real estate not used in operation.

Subway Elevated System

The subway-elevated system on Market Street, which was placed in operation in 1907 and 1908, is modern in every particular and was designed with careful attention to the best points of design and also to the defects of other railways of this class both here and abroad. It is generally conceded by engineers that this is the best elevated railway and subway constructed in this country.

The subway-elevated system comprises 7.52 miles of double-track on Market Street and Delaware Avenue, 2.06 miles being subway under Market Street, 3.67 miles elevated on Market Street and 0.79 miles elevated on Delaware Avenue. There are twelve stations on the elevated structure, or about 2.7 per mile, and six stations in the subway section, or 3 per mile. The station at the western terminus is also used by the Philadelphia and West Chester Traction Company and the Philadelphia and Western Railway Company. The system is equipped with automatic signals designed to admit of a minimum headway of 1½ minutes. From the Schuylkill River to Juniper Street, a distance of 1.25 miles, the subway contains four tracks, two of which are used exclusively by surface cars which run to Darby and various points in West Philadelphia. The incline from subway to viaduct on the west is located over the Schuylkill River. At the eastern end the subway turns to the north at Front Street under property acquired for the purpose, rises to the elevated level at Arch Street and then turns southward along Delaware Avenue. There are stations for the subway-surface cars at 19th Street, 15th Street and Juniper Street.

At June 30, 1910, the Company owned 100 steel cars for use on the subway-elevated system. Twenty cars have been added since this date. Adequate shops and yards are located at the western end of the line.

A large proportion of the westbound passengers on the subway-surface lines board the cars at Juniper Street. The platforms are very little above the level of the track and there are no gates to control the loading. This arrangement is unsatisfactory at evening rush hours as it is inconvenient for passengers to climb the steps in crowds and one minute per car is consumed in loading. If the loading arrangements were improved, the number of cars could be increased about 50 per cent. when needed. Further increase in traffic can be provided for by the use of trailers. The subway-surface stations are poorly lighted and they should be provided with seats, as the interval between base schedule cars on some lines is as much as ten minutes.

SURFACE CARS

The car is the most important part of the street railway property from the standpoints of both the public and the company. Upon the car design depend largely the comfort and satisfaction of the passenger on the one hand, and on the other, the amount of riding per capita per year and the cost of operation. A street railway company may store its cars in dilapitated barns or in the open air, may supply itself with power from a plant of poor design and may even have its track and overhead line of inferior standard yet may render satisfactory service to the public, provided its cars are modern, comfortable, cleanly and well maintained. Defects of the other portions of the company's property increase the cost of operation and affect the financial return, but defects in car standards are instantly noted by the public and react in numerous ways upon the corporation. Consequently, the management should give every possible attention to its car design and construction, and should see that the character of its rolling stock is kept well abreast of modern practice. In adopting a standard car the management should give careful consideration to all points of design, both large and small, which will gain the appreciation of the public, and at the same time provide for economies of space, weight and platform expense.

The history of the electric street car covers the period of about the last 20 years. The first cars operated by the overhead trolley system in Philadelphia were used on the Catharine and Bainbridge Streets line in 1892. The electric equipment of most of the Philadelphia lines covered the three years from 1892 to 1895 and consequently the design of the electric cars with which the Philadelphia system was first equipped comprised some of the earliest standards known to the electric car builder's art. The car bodies were slightly larger and more substantial than the horse cars and cable cars previously in use and were mounted on single 4-wheel trucks with motors of small capacity. During the first decade of the electric car this small single-truck car was the standard; the development of the roomy, double-truck, cross-seat semi-convertible car took place in the second decade from 1900 to 1910. Double-truck cars during this period in other cities reached a maximum size and weight and the latest practice has been along lines of a smaller car whose light weight, comfortable seating capacity and ample size give economical service during the non-rush hours which comprise the large part of the operating day, together with elasticity of overload capacity during the rush hours.

Although the Philadelphia system was equipped with the early types of electric cars, practically all of which are still retained in operation, it may be stated that the broad policy of some of Philadelphia's early traction companies dictated the design of the best longitudinal-seat, single-truck cars used in the United States. These cars, it is believed, have given as good satisfaction to the public as the limits of that type would permit.

The policy of the other original traction companies and of the early consolidations, however, has apparently subordinated comfort, convenience and popularity almost entirely to first cost. In addition to buying the cheapest cars obtainable there seems to have been little attempt on the part of the management to determine the fine points of car design as embodied in the wishes of the public and the standards in use in other cities.

From the standpoint of the public, other errors of policy would appear to have been made in the rebuilding of old fashioned single-truck cars into slightly longer double-truck cars by splicing and reconstruction and in the conversion of fairly comfortable, cross-seat, convertible cars into the longitudinal-seat type of Pay-Within car, where the convenience of the public has been subordinated to other considerations, which, though important in themselves, should not have been given undue weight.

This Company, while retaining the old horse-car plan of duplicate summer and winter equipment, has during the last ten years purchased only cars which, after alteration to Pay-Within cars, have become longitudinal-seat closed cars of a type generally uncomfortable during hot weather. In other words, its present policy seems neither to follow the older theory of duplicate summer and winter equipment, nor on the other hand to add new cars suitable for both seasons.

Type of Cars Owned—Philadelphia and Other Cities

The surface cars owned by the Philadelphia Rapid Transit Company as of June 30, 1910, are as follows:

TYPE OF CARS OWNED—PHILADELPHIA

	Single Truck	Double Truck	Total
Open	1,074	164	1,238
Closed	1,010	1,044	2,054
Total	2,084	1,208	3,292
Per cent. of total cars	63.3%	36.7%	100%

The number of closed cars operated in the maximum winter schedule under present car assignment is 624 single-truck and 1,048 double-truck, a total of 1,672 cars.

A comparison of the rolling stock with that used in other large cities having representative equipment and governmental regulation is of interest. The number of cars owned by the two largest surface systems of Manhattan Borough, New York City, as of October 1, 1910, was as follows:

TYPE OF CARS OWNED—NEW YORK

	Single Truck	Double Truck	Total
Open	301	464	765
Closed	500	1,935	2,435
Total	801	2,399	3,200
Per cent. of total cars	25.0%	75.0%	100%

The number of closed cars required for operating the maximum winter schedule for these two systems in Manhattan is 469 single-truck and 1,785 double-truck cars, a total of 2,254 cars.

Similarly, the cars owned at the same date by the street railway systems of Brooklyn were as follows:

TYPE OF CARS OWNED—BROOKLYN

	Single Truck	Double Truck	Total
Open	169	1,010	1,179
Closed	103	1,741	1,844
Total	272	2,751	3,023
Per cent. of total cars	8.9%	91.1%	100%

The maximum winter schedules for these systems require the operation of 100 single-truck and 1,676 double-truck cars, or a total of 1,776 cars.

In Chicago the Traction Settlement Ordinances of February 11, 1907, required in the rehabilitation of the two large street railway systems, that these companies increase their large double-truck cars during the three-year rehabilitation period to a total of 2,000. The companies were specifically allowed to retain in operation 1,301 open and closed single-truck cars, so that of the total of 3,301 cars, 60.6% were to consist of double-truck cars. It is understood that at the present time, the car equipment of these Chicago systems consists of approximately 2,200 double-truck and 725 single-truck cars, a total of approximately 2,925 cars, so that voluntarily these companies have increased the proportion of double-truck cars to 75% of the total.

It will thus be noted that while the car equipment of street railway systems of New York, Brooklyn and Chicago consists of 75%, 91.1% and 75% respectively, of double-truck cars, that of Philadelphia comprises only 36.7% of this class of car.

Life of Cars

In other words, these other systems have replaced a large part of their first electrical car equipment, while the Philadelphia system has retained most of its similar equipment. The age of this equipment, which, in Philadelphia, is from 16 to 19 years, should not necessarily cause a lack of usefulness due to physical deterioration, nor can it be said that the life of a well built street car should be no longer than this. As a matter of fact, from the standpoint of wear and tear, a car, if well maintained, can be preserved almost indefinitely, as each part when worn out would be replaced with new material. Its economical life, however, can be definitely ascertained.

In the case of steam railroad passenger equipment, the useful life of cars is often from 30 to 40 years. With steam railroad freight cars, however, as the first cost of the car is comparatively small, and the type of equipment has changed so rapidly, due to the economy of operating large units, it is not found desirable to retain cars for a longer average life than from 15 to 20 years. The same principle of economical operation has sealed the fate of the single-truck street railway car for use on congested lines of many large street railway systems. With the advance in the art, with the careful designing of the car to embody all presently conceivable points of operating efficiency, and with the requirement by public opinion and governmental authority to charge the cost of replacement to income account instead of to capital, it is believed that the modern street car with proper maintenance will have a life con-

siderably in excess of 15 to 20 years and probably as much as steam railroad cars of a settled economical design the life of which is placed by competent authorities at from 25 to 35 years.

Car Requirements for Recommended Service

The small single-truck car has its usefulness in street railway systems in large cities for lines of light, regular traffic which do not traverse the congested tracks of the down-town delivery district. Philadelphia has a large amount of track mileage and a large number of separate lines for the population served. It would therefore be expected that a larger proportion of single-truck cars can be used to good advantage in Philadelphia than in the other cities named. The principal objection to single-truck cars is to their limited size and not to the four-wheel truck. A modified design of the latter such as a radial-axle truck may permit the use of longer car bodies and thus remove this disadvantage.

Based upon the recommended service for the surface traffic of October, 1910, there would be required a total winter car equipment of 922 single-truck cars and 1,547 double-truck cars including maximum-traction cars, or a combined total of 2,469 cars of which the double-truck cars would represent 62.7%. This allows for reserve cars in shop and assumes the operation of 838 single-truck and 1,427 double-truck cars, or a total of 2,265 cars. This would require the purchase of 489 additional double-truck cars. As the present single-truck cars for winter service are all of the box-car type it would be desirable to retain an equal number of open single-truck cars for use on the same lines in summer.

Cars Purchased in Past Ten Years

During the past ten years there have been purchased for the use of the Philadelphia surface system, 655 double-truck closed cars and for the subway-elevated, 100 cars. This compares for the same period with a total for the two surface systems of New York City of 1,472 double-truck cars, consisting of 142 open cars and 1,330 closed cars, and with a total for the Brooklyn system of 1,007 closed double-truck cars. In Chicago, it is understood that all of the 2,200 double-truck cars have been bought during the past ten years. In New York, however, in addition to these surface cars, all of the 1,146 subway cars and a large number of elevated cars have been added during this period, and in Brooklyn and Chicago large numbers of elevated cars have been purchased. Consequently, it appears that the Philadelphia system has added during the same time a smaller proportion of new equipment than have the systems of these other cities.

Comparison of Present Street Car Standards in Philadelphia and other large American Cities

In order to develop recommended standards of car design, it is necessary to consider the detailed design of each of the principal types of cars used in Philadelphia, especially that of the present standard, the Pay-Within car, and then to compare these with the standards adopted by the principal street railway systems of other large American cities. These comparisons have been made in the form of tabulated statements comprising the general design of the eight principal types

of surface cars of the Philadelphia Rapid Transit Company and details of design affecting the traveling public. The same particulars are shown in other statements where comparisons are drawn between the Philadelphia Pay-Within car and present standards of surface cars of New York, Brooklyn, Boston and Chicago, and also between the Philadelphia Subway-Elevated car and the latest subway car standards of New York City.

Principal Types of Philadelphia Surface Cars

Considering first the general design of Philadelphia surface cars there are shown statistics of the eight principal types of cars operated, comprising 1,666 cars out of a total owned of 3,292. Of these eight types 992 are double-truck cars out of a total of 1,208 owned. The total cars owned by the Company are of 36 types, those not shown being of least importance as to numbers and future service. Of the eight types here considered four, viz: E-41, E-42, E-43 and E-44 are double-truck closed or semi-convertible cars with 28-foot bodies, and another type, C-6, is a 24-foot closed, maximum-traction truck car reconstructed from a single-truck car by splicing in a section in the middle. The remaining three types consist of, B-1, a 20-foot closed single-truck car, P-1, a 10-bench, single-truck open car, and R-4, a 12-bench open maximum-traction truck car with centre aisle.

Of the four types of 4-motor, double-truck cars, three, namely, E-41, E-43 and E-44, are variations of the Pay-Within type, and the other, E-42, comprises 65 closed cross-seat cars. These four double-truck types have a maximum length over bumpers of 38′ 10″, a maximum width of 8′ 6″ and weigh from 1,042 lbs. to 1,164 lbs. per seat. They have short wheel-base trucks and short truck centers. All of these outside dimensions are limited by the narrowness of the Philadelphia streets, and on the Ridge Avenue lines a specially narrow car has to be used.

Economical Car Design

The features of general dimensions, weights and types of car bodies, trucks and motors are of controlling importance in connection with the economical operation of the car equipment. These, however, should be the subject of careful study and determination by the Company's operating officials and engineers. It is understood that the Philadelphia Rapid Transit Company is making experiments upon radial-axle trucks and on the use of trailers, and also has made an elaborate study of roller and ball-bearings for car axles and car motor journals, all of which should be of assistance to them in determining an efficient future standard. There are many such possibilities of economy which can be considered without detriment to the public's comfort and which should enable the Company materially to improve the car service at periods of maximum load.

There are many features of car design, however, which directly affect the public comfort and convenience, and special discussion will here be given of these details. In the tabulated statements in Vol. II of the eight types of Philadelphia surface cars, special attention should be given to the Pay-Within car as exemplifying the present standard. As of January 1, 1911, 700 cars have been converted to Pay-Within cars, this representing 67% of the Company's double-truck closed

(including maximum-traction) cars and 34% of total double and single-truck closed cars owned. On an average about 40% of the maximum cars operated in winter are of the Pay-Within type. The other types of car shown represent, as stated, the best of the remaining cars. In view of their probable replacement in a few years it would not be desirable to alter these cars to any great extent, nor, due to the fact that they are largely of old model, will they be of much service in the determination of future standards.

Comparison of General Design of Standard Surface Cars

A comparison is shown of car standards of the following companies:

Metropolitan Street Railway Company (of New York),
Third Avenue Railroad Company (of New York),
Brooklyn Rapid Transit Company,
Boston Elevated Railway Company,
Chicago City Railway Company,
Chicago Railways Company,
Philadelphia Rapid Transit Company.

Dimensions and Weights

The length of cars over corner posts varies from 28′ 0″ in Brooklyn and Philadelphia to 33′ 3″ in Boston, and the length of cars overall from 38′ 3¾″ in Brooklyn to 46′ 11″ in New York (Metropolitan). The maximum width overall varies from 8′ 0½″ in Brooklyn to 8′ 6″ in Boston, Chicago and Philadelphia. The average overall dimensions of these types might be said to be 32′ in length over corner posts, 46′ overall and 8′ 3″ in width. The weights of empty cars vary from 35,200 lbs. in Brooklyn to 56,650 lbs. in Boston, and the weights per seat from 864 lbs. in New York (Third Avenue) to 1,325 lbs. in cars of Chicago (City Railway).

Electric Equipment

With regard to electric motor equipment, the Brooklyn and two New York companies use two motors per car, and the others four motors per car. The 2-motor equipments vary from a total capacity of 100 H. P. to 130 H. P. and the 4-motor equipments from 160 H. P. to 200 H. P.

Trucks

On the 4-motor cars, double trucks are used, with wheel base of from 4′ to 6′ 4″, with truck centers from 16′ 0″ to 22′ 11″. The three car standards using 2-motor equipments all have center-bearing maximum-traction trucks, which in the case of the two New York companies have the driving wheels toward the center, thus permitting a very desirable increased distance between truck centers up to 24′ 0″ as compared with the Brooklyn car in which the pony wheels are towards the center and the distance between truck centers is only 15′ 1¾″. With all of these companies rolled steel wheels are standard, except the Boston company which uses steel tired wheels. This indicates an abandonment of the cast iron wheel, thus largely eliminating the disagreeable flat wheel and reducing derailment accidents.

Comparison of Details of Standard Surface Car Design affecting the Traveling Public

Considering surface car design from the standpoint of the public, there should be adopted wherever practicable, those features, both large and small, which contribute to the safety, comfort and convenience of the street car traveler.

Signs

Taking up the various points of design as they would be encountered by the passenger, the first items of importance as the car approaches are the line and destination signs. In the Philadelphia car there is a wooden sign, not illuminated, on each upper side deck, giving the line designation. An additional glass sign is placed on the end of the vestibule hood, illuminated from the car lights, which generally gives the car destination. The objectionable features of these Philadelphia car signs are, first, poor illumination, and second, the lack of a definite system of designating line or destination. This latter has apparently been the result of the gradual development from the original horse-car routes without careful revision as a whole. For instance, on the Lehigh Avenue Line in the upper part of Kensington, the cars are designated only by the words "Fairmount Park," this being a case where the destination named comprises an area about eight miles long, located in the other extreme of the city, and there is no clue as to the route.

In Boston, the route and intermediate points are designated by wooden signs on the front and rear hood and on the sides of the lower deck, not illuminated. The destination signs are removable steel plates in the middle vestibule space under the hood, specially illuminated, and in addition metal disks show the division number.

In Brooklyn translucent line signs are shown in the ends and sides of the car monitor and wooden block destination signs are placed in the corners, specially illuminated. The two New York companies and the two Chicago companies use "Hunter" cloth signs either in the front and sides of the car monitor or in the middle of the vestibule under the hood, and in the upper part of the windows at the center of the side of the car. The monitor signs are illuminated from the car and the vestibule signs by lamps provided for the purpose.

It is recommended that transparent line signs be provided for front, rear and sides of the monitor, illuminated by the lights in the car, and in addition a destination sign in the center of front and rear vestibules under the hood, independently illuminated.

Step Height

In boarding the car the first feature of interest to the passenger is the step. On the present double-truck closed cars in Philadelphia, the height of the first step from the ground varies from 15½ to 17¾ inches, while with the single-truck closed cars this is as low as 11 inches, and with the open cars it ranges from 17½ to 20½ inches. The second step on the closed cars averages 13½ inches and on open cars 15 inches, while the third step from the platform to the interior of the car varies from 5¼ to 9¾ inches for the double-truck cars and 5½ inches for the single-truck closed cars, while, of course, on the open cars the platform is at the same level as the interior. With

the New York and Brooklyn maximum-traction cars the first step ranges from 14½ to 15½ inches, the second step is 13 inches and the third step averages 9¼ inches. In the Chicago cars the first step ranges from 16½ to 18 inches, the second step averages 14 inches and the third step 11 inches, while with the Boston car there are three steps to reach the platform, these being 15½, 12 and 11½ inches. The height of steps on closed cars where there are two steps from ground to platform and one step from platform to interior, is dependent on type of truck used, diameter of wheel, design of bottom framing, and size of motor. With the standard double-truck 4-motor equipment, the height of the car floor from the ground (which is here assumed to be even with the head of the rail) is, of necessity, from 38 to 42 inches or more, and this involves a first step of about 16 inches. With the use of the Metropolitan type of maximum-traction car it is possible to reduce the total height of car floor from ground to 37½ inches and to reduce the height of the first step to 15 inches, a convenient height of the second and third steps being 13 and 9½ inches.

If the use of a radial-axle, single-truck type of car with large motors proves to be practicable, it would permit of a still further reduction of about 1½ inches in the total height of the car floor from the ground and height of steps. Any reduction in the height of steps is a matter of great importance, especially to women and children. The reduction of three inches in the height of the first step of the Metropolitan cars below that of the type previously used was the cause of much favorable comment.

Tread Width

In order to decrease the liability to accidents it is also important to provide that the width of the step should equal about the length of the foot or from 10 to 12 inches, so that the passenger when alighting is able to rest the entire foot on the step, as against the ladder effect of a narrow step. The Philadelphia Pay-Within cars are well designed in this particular as the width of the step is 12½ inches. In the other cars considered, this width varies from 10 to 10¾ inches, although in Boston with the use of three platform steps it is reduced to 8¾ inches. The effect of a narrow tread and a high step upon step accidents is quite noticeable in the case of open cars where, as in the Philadelphia cars, the running board is 7½ inches wide and the steps as high as 20 inches or more. With regard to the kind of tread to be used, the Philadelphia Pay-Within cars have a hinged step with wooden tread, while standard cars of New York, Brooklyn and Chicago have the "Universal Safety" or the "Mason" tread, which is a metal plate with soft metal inserts. The use of a safety tread and also of folding or protected steps is recommended, the latter preventing "hanging on" when the step is not in use.

Prepayment Cars

A prepayment system of fares necessitates that the entrance be on the rear platform and that the entrance and exits be controlled by the conductor or motorman. While this is primarily for the purpose of immediate fare collection on entering, it also, by reason of the conductor being located near the rear entrance, eliminates largely the step accidents, which with the usual type of car form a large class

of casualties. From the standpoint of safety and convenience to the passenger, business-like methods of fare collection and proper control of the car operation by the conductor, the prepayment plan with the use of operating platform doors, is a great improvement in car design.

The Pay-Within and other Systems of Fare Prepayment

As to the kind of doors which are adopted and the method or details of prepayment of fare, various plans have been proposed and used, two of which at least are stated to be covered by patents, viz., the "Pay-Within" and the "Pay-As-You-Enter" cars. The Pay-Within car as used in Philadelphia is merely one type of the Pay-Within method of fare collection with doors, which seemed to the designers to be most practicable in adapting this system to the small-platform double-truck closed cars. The two Chicago and the Third Avenue companies use the P. A. Y. E. system. The Metropolitan Company in its standard car uses a specially designed prepayment system. The Boston company uses sliding platform doors with folding steps, these being operated by the motorman at each stop. On the Brooklyn standard car, gates on the front platform are operated by the motorman, while the rear platform gates are not used and the prepayment of fare is not required.

The main point of difference between the Pay-Within and the Pay-As-You-Enter systems heretofore has seemed to be the design and control of platform and bulkhead doors. The Pay-Within plan is understood to provide for the control of the rear platform doors by the conductor in connection with the prepayment of fares. The P. A. Y. E. plan has usually provided that the rear platform doors be permanently open, the bulkhead doors being the operating doors. It is understood, however, that in some recent P. A. Y. E. cars, the principle of mechanical control by the conductor of the rear platform doors has been adopted.

With regard to the Pay-Within plan, statistics have been obtained from the Pay-Within Car Company as of September 15, 1910, showing that this plan has been used on a large number of cars of various types by representative systems. The date at which the first car of this type was used by each of these companies, the amount of the first order and the total number on order at September 15, 1910, are as follows:

		Pay-Within Cars	
		First Order of Cars	Total Cars Ordered
Sept. 27, 1908	Philadelphia Rapid Transit Co.	50	726
July 6, 1909	Capital Traction Co., Washington, D. C.	11	35
Aug. 26, 1909	Public Service Railway Co., Newark, N. J.	29	504
Mch. 18, 1910	Cleveland Railway Co., Cleveland, Ohio	100	250
June 8, 1910	Illinois Traction System, Bloomington, Ill.	20	34

The design of these cars has varied from single and double-end cars, as used in Philadelphia, with the sliding door, pneumatically operated and folding steps, to inward and outward folding doors or gates of two or four leaves each, operated by air or hand, with fixed steps. The length of rear platform on these various types of Pay-Within cars ranges from 4′ 0″ (4′ 2″ in Philadelphia) to 7′ 4″, and the position of the conductor is either on the rear platform with the long

platform, or on the car floor at the rear bulkhead with the short platform. These various cars are equipped with longitudinal seats, as in Philadelphia, or with both cross and longitudinal seats, and the car bodies themselves have been built by practically all of the large car builders. The adoption of various prepayment plans has been rapid, and large numbers of cars of these types are now in use.

It is believed that keeping the rear platform doors closed while the car is moving, whether these doors are controlled by the conductor, as in the Pay-Within plan, or by the motorman, as in the Boston or Minneapolis cars, is a most valuable safeguard against accident, and on any but possibly the most congested lines in the largest cities, will not tend to delay unreasonably the car operation or to lengthen the headway. The control of the front-exit door by the motorman is also desirable. The principal difficulty with the Philadelphia Pay-Within cars seems to be in the use of too small a rear platform and narrow rear platform door, these necessitating the location of the conductor inside the car bulkhead where he is in the way of free passenger movement and prevents the entrance and exit simultanously of two lines of passengers.

Single-end Cars

The usual prepayment plan with entrance and exit from rear platform and exit only from the front platform lends itself especially to the single-end type of car. The objections to the operation of single-end cars would not seem to apply with the usual force to the street railway system of Philadelphia as 58% of the line is single track practically all operated in one direction, so that in cases of emergency it would be impracticable to switch cars directly back to the other track as may be done with a double-track line and double-end cars. The single-end cars eliminate a certain amount of weight and first cost, besides saving from 2 to 3 lineal feet in the amount of track space occupied and about 6 inches in the length of rear platform. They, however, require loops or Y's at the terminals for turning the car, with the same facilities at intermediate turn-back points.

Size of Platform

The rear platform of a prepayment car should be of sufficient size to permit of the independent entrance and exit of passengers at the same time. Allowing a width of 23 inches each in the clear for entrance and for exit, means practically a 4-foot opening at step. The present opening on the Philadelphia standard car is 34½ inches for a platform 4′ 2″ in length. This compares with a total opening in the New York prepayment cars of from 4 to 5 feet with platforms from 5′ 10″ to 6′ 10″ in length, and with total openings in the Chicago cars of about 4′ 7″ and platforms from 6′ 1½″ to 6′ 3¾″ in length, all lengths of platform being inside measurements from bulkhead to dash.

Experience and test have proved that for a 28 to 30-foot car a platform of from 5′ 6″ to 6′ 0″ (inside) is of sufficient length to accommodate the usual passenger loads at average heavy stops.

With the use of the maximum-traction type of truck similar to the New York (Metropolitan) car it would be possible to separate the truck centers sufficiently that the overhang on the outside of curves with a 28-foot car having a platform 5′ 6″ (inside) would not be

greater than that of the bumper of the present Philadelphia standard car. This length will provide room for the conductor on the platform.

Platform Doors

Another serious objection to the Philadelphia Pay-Within car is the sliding platform door. This type of door besides being difficult to keep in line, involves a heavy mechanism usually required to be operated by air. This is expensive, requires frequent adjustment, and in case of disarrangement or accident it is difficult for a passenger to release. Probably the most serious objection to the sliding door, however, is the necessary pocket into which it slides in the side of the car, which contracts the space at the car entrance where congestion is most apt to occur. The combination of this narrowing of the neck of the bottle together with the location of the conductor at the same point as a stopper forms, it is believed, the most serious objection to this present type of car.

It seems to have been unwise for the Company to have expended approximately $1,000 per car to alter the more comfortable cross-seat car previously in use as the Company's standard into a car of this type, when by an expenditure of about 60% of this amount this car could have been changed into a prepayment car with rear platform of sufficient size and with a convenient design of platform door.

On the New York and Chicago prepayment types of car a sliding platform door is used for the right-hand of the front platform providing an exit from 24 to 27 inches in width and folding doors on the right-hand of the rear platform locked open while the car is in operation. The front door is opened either by the passenger or by a motorman's hand lever or automatically by release of foot lever and is locked shut by motorman. On the rear platform a pipe stanchion divides the entrance and exit, and a pipe rail separates the exit and shields the conductor from the entering passengers.

It is recommended that for the Philadelphia standard car, folding platform doors be provided similar to those frequently used on the Minneapolis or Pay-Within types of car and also used recently in connection with the P. A. Y. E. car. These doors should be operated mechanically, the front platform door being operated by the motorman and those on the rear platform either by the conductor or motorman. The operating device should be under the control of the car operatives, and so simple that in case of accident the door could be opened by passengers.

Bulkhead Doors

With the use of the Pay-Within type of platform door the bulkhead doors may be omitted, as in this case the platforms are closed to the weather. This eliminates some weight and expense and permits a freer movement of passengers. In sleet storms the motorman is sometimes obliged to lower the vestibule sash. This might necessitate a folding cab or shield behind the motorman to protect the passengers.

In the New York and Chicago prepayment cars, as the rear platform doors are not used in operation, bulkhead doors are required, these in the case of the Chicago P. A. Y. E. doors being single sliding doors providing 23 inch openings, and in the case of the New York

prepayment cars being double sliding doors providing openings of the same width.

In the present Philadelphia standard car the bulkhead passage-way is 28½ inches wide but is, however, as stated, somewhat obstructed by the location of the conductor at this point. It is recommended that the width of the entrance and exit at the bulkhead be not less than 23 inches each, these two passage-ways being conveniently separated by a pipe stanchion.

Grab-Handles

For the safety and convenience of passengers entering and leaving cars grab-handles are installed in the Philadelphia car on the body and vestibule corner posts of both platforms. In the New York and Chicago prepayment cars a grab-handle is installed on the front vestibule corner post, and for the rear steps of the Chicago cars on the body and vestibule corner posts, the pipe stanchion from platform to hood acting also as an additional grab-handle at this point. On the New York cars there are grab-handles on the rear body corner posts but none on the vestibule corner posts of the rear platform as passengers entering the car should properly grasp the pipe stanchion at the right hand.

Fare Collection and Registration

With the Philadelphia Pay-Within car the conductor collects the fare at bulkhead entrance and makes change in the usual manner, registering the fare by hand register cord. In the New York prepayment cars the conductor makes change on the rear platform, the fare being placed in a removable cash box. On the Metropolitan car the registering of fares is by hand strap or foot lever, but on the Third Avenue car registration is made by registering fare box. On the Brooklyn car the fares are collected by the conductor without prepayment being required and are registered by hand register cord. On the Chicago cars the conductor collects fares on the rear platform, registering by foot lever with a hand cord for emergency. On the Boston car fares are collected by the conductor without prepayment, cash and ticket registers being provided, operated by hand cords. The location of the conductor on the rear platform and prepayment of fares are recommended, and the method of cash collection and registration should be such as suit the convenience and reliability of the Company's accounting system.

Seats

Probably the most serious popular indictment against the Philadelphia standard car is the discomfort of the longitudinal seats, caused largely by their dimensions and form. In view of the fact that the car trips in Philadelphia are 50% longer than in other large cities and that the surface car rides of a large number of the passengers are of necessity of great length due to there being few high speed lines in this large area, comfortable seating arrangements for passengers should be provided.

In the cross-seat double-truck car at present in use in Philadelphia there are 12 double cross seats for 24 passengers and 4 longitudinal seats seating 4 each, or a total capacity of 40 seats. This car is 8′ 6″ in width over all and with cross seats 33″ long, has an aisle 21½″ wide. When converted into the Pay-Within type it has a seating capacity of 38 at the usual spacing for longitudinal seats of from 17 to 18 inches per seat. The four small longitudinal seats in front of the platform door pockets, however, are extremely uncomfortable due to their being little more than a shelf 13½″ wide with a straight back only 10″ high. These spaces representing 8 seats out of the 38 or over 20% of the seating capacity, cannot be much improved without a more serious interference with the passenger movement, but they should never be duplicated.

The main longitudinal seats in this Pay-Within car are 18½″ in height, 17″ wide, have a slope of 1½″ and are constructed of spring rattan; the backs are 12″ high, have a slope of 3½″ and are made of rattan backed with wood. They are not comfortable, however, due largely to the fact that the backs are too low, are not constructed of spring rattan and neither seats nor backs have the proper slope. If the backs were constructed of spring rattan it would make them more comfortable, although in the New York (Metropolitan) cars where both seats and backs are constructed of rattan without springs but backed with felt and wood, a comfortable seat is provided by a proper curvature of seat and back, this tending to prevent slipping.

One of the most comfortable longitudinal-seat cars ever built is the Philadelphia (People's Traction) 20-foot box car. If the design of the seats in that car were duplicated for the longitudinal seats of the Pay-Within car there would be a considerable improvement. These seats are properly sloped and the backs are of spring rattan and 16 inches in height. It is recommended that the longitudinal seats and backs which are retained in the Pay-Within cars be remodelled along the lines of these or of the Metropolitan seats. By making a moderate expenditure for this improvement the comfort of these cars can be largely increased.

The standard cars of Chicago with 32-foot bodies seat 40, of which 28 are on cross seats and 12 on longitudinal seats at the ends of the car. In the New York (Metropolitan) car the capacity of seats, all longitudinal, is 42 exclusive of 5 front platform seats, while that of the Third Avenue car, exclusive of 3 platform seats, is 44, of which 40 are cross seats and 4 longitudinal. The Brooklyn car has 36 longitudinal seats and the Boston car 52 seats, of which 36 are cross seats and 16 longitudinal. In all of these the seats and backs are made of spring rattan except in the Metropolitan and Boston cars, the former having rattan backed with felt and concaved shaped board, and the latter having wooden slats. The length of these cross seats varies from 31 to 34 inches and the spacing between centers from 28½ to 31½ inches.

Standing Room

The standing room of a surface car is considered as the available aisle and platform space. From experience and test of various types of cars it has been found that an available standing space of 4 square feet per standing passenger provides sufficient room for comfort

and for free movement through the car. This for a longitudinal-seat car means practically two rows of standing passengers in the car, providing aisle space for passenger movement between. Application of this rule to the Philadelphia Pay-Within car with allowance for entrance space on rear platform, would result in 38 standing passengers or the same number as seated, permitting a total load of 76.

For the Philadelphia cross-seat 28-foot car (type E-42) this rule would result in 29 standing passengers and 40 seated. For the other cars it would result as follows:

PASSENGER CAPACITY

	Seated	Standing	Total
Metropolitan	42	42	84
Third Avenue	44	26	70
Brooklyn	36	36	72
Chicago	40	36	76
Boston	52	39	91

Therefore, for a longitudinal-seat car this rule means generally as many passengers standing as seated, while for the cross-seat car the standing passengers will represent from 60 to 90 per cent. of the seated passengers. The total seating and standing capacity of the longitudinal-seat car is therefor about 10% greater than that of the cross-seat car of the same dimensions.

In a 28-foot cross-seat car body with platforms 5′ 6″ (inside) which for the purpose of this report is assumed as the future Philadelphia standard, the standing capacity would be approximately 36 in addition to 40 seats. While the standing capacity is based on 4 square feet per standing passenger, the total seated and standing capacity of the interior of the car will equal about 3½ square feet per total seated and standing passenger, which is about the same proportion as exemplified by recent American practice and certain governmental regulations abroad.

Steadying Methods

The steadying methods inside of the Philadelphia standard car consist of 36 leather straps, 4 stanchions at the bulkheads and 2 conductor's stands. On the Metropolitan and Brooklyn longitudinal-seat cars there are 32 and 34 leather straps respectively and in the Metropolitan car there are pipe stanchions on front and rear platforms and conductor's rail on rear platform. On the Third Avenue, Chicago and Boston cross-seat cars there are corner hand-holds or grab-handles on the back of each cross-seat, with from 8 to 16 leather straps over the longitudinal seats, and in the case of the Boston car 14 additional leather straps over the cross seats. The height of the leather straps varies from 5′ 2″ to 5′ 11″, a fair average being 5′ 7″ used in Philadelphia and New York.

It is understood that experiments are now being made by the Company on the use inside the car of vertical pipe stanchions which if used should have sanitary or white enameled coating. Hand-holds or grab-handles should be used on the back of each cross seat and in the case of longitudinal-seat cars careful consideration should be given to the sanitary or white enameled horizontal hand rail of the Hudson

Tunnel car in connection with the vertical stanchions and also to the steady-holds used in place of straps in the latest type of New York subway car. The latter are made of iron, white enameled, and hinged in the direction across the car but immovable as to the length-wise direction. They are hung in the same position as the usual leather straps at about the same height but when not in use a spring draws them somewhat away from the aisle.

Additional steadying devices are needed in the Pay-Within car as is shown by the large number of accidents from passengers falling on platforms and in the car. Some of the above methods should be adopted inside the car, and pipe stanchions, rails or grab-handles installed on platforms.

Windows and Ventilation

Objection has been made to the lack of airiness in the present Philadelphia standard car in summer and also as to poor ventilation in winter. Statistics were collected showing the area of front and side openings of this and other cars available for passage of air as operated in summer. The area of the front opening of the principal types of Philadelphia cars is as follows:

	Area Front Openings (sq. ft.)	Ratio Front Openings to Front Area
Pay-Within Car	16.2	24.9%
28′ Cross-seat Car	6.1	9.4
20′ Single-truck Car	5.1	8.4

The total area of side openings of windows and monitor ventilators on these cars (not allowing for removal of fixed sash) follows:

	Area Side Openings, Windows and Monitors (sq. ft.)	Ratio Total Side Openings to Side Area	Ratio Total Openings to Total Area Front and Side
Pay-Within Car	48.0	20.8%	21.7%
28′ Cross-seat Car	15.6	6.8	7.3
20′ Single-truck Car	8.2	5.0	5.9

As these figures show that the Pay-Within has much larger available window openings than the cross-seat car, it would seem that the apparent lack of air movement is due to the arrangement of the seats. In the cross seat the passenger is facing the front of the car and would notice a current of air which is not perceptible in the longitudinal seat.

A series of observations was made on September 6, 1910, from 1.30 P. M. to 5.00 P. M., this being a fairly hot day, to determine the average amount of the possible window opening of the Pay-Within cars which was actually used. These observations were made at 13th and Chestnut Streets, on 11 lines and 194 cars on both streets, and at Front and Market Streets, on 5 lines and 103 cars on Market Street. The street temperatures were considerably higher than those recorded by U. S. Weather Bureau which showed a maximum of 84° F. and mean of 76° F. for the day.

It was found that 89% of the possible front and rear window openings were opened and that 92% of possible side window and monitor openings were opened, so that it would appear that sufficient air currents were available if the seats had been properly disposed.

A comparison with the window openings of cars of other cities is as follows:

	Area Front Openings (sq. ft.)	Ratio Front Openings to Front Area	Area Side Window Openings (sq. ft.)	Area Side Monitor Openings (sq. ft.)	Ratio Total Side Openings to Side Area	Ratio Total Openings to Total Area, Front and Side
Metropolitan	7.6	11.2%	59.2	7.3	25.4%	22.2%
Third Avenue	7.3	11.0	107.2*	7.8	47.3	39.5
Brooklyn	6.3	9.8	82.6*	10.0	40.3	33.6
Chicago City Ry.	19.2	27.5	76.9	14.0	34.7	33.2
Chicago Railways	16.4	23.5	55.5	4.0	23.1	23.2
Boston	8.7	13.5	71.2	9.7	28.5	25.7
Philadelphia	16.2	24.9	27.3	20.7	20.8	21.7

* Summer operation.

It should be noted that these figures do not include for the Chicago City car, patented ventilators in front and rear monitor, ventilators on floor of car and ventilators on top of hoods; neither does it include the special ventilating system used in the Chicago Railways car, nor the openings in side vestibules of the Boston car.

The Philadelphia car of type E-41, which is a 28-foot semi-convertible car changed to Pay-Within type, has much larger side window opening than the other Pay-Within cars, this being 53.8 square feet, which gives it a ratio of total side and front openings to total area of 27.4%. The area of all window openings of the Philadelphia Pay-Within car compares favorably with the cars of other cities named, the only cars having an appreciably larger ratio of window opening being the Chicago City, Third Avenue and Brooklyn cars, which last two types have removable sides and windows. With a car having longitudinal seats it is believed to be undesirable to remove the windows in summer, and it would seem that no material improvement can be made on the present Pay-Within cars in this particular if the use of longitudinal seats is continued. For a new standard car, however, it is recommended that the side window openings be considerably enlarged.

Window Guards

The Philadelphia car uses a double bar side window guard and the Third Avenue, Chicago and Boston cars all use iron screens from 12½″ to 2′ 6″ wide. The Metropolitan and Brooklyn cars use no side window guards, the necessity for these being determined by the clearance between cars on double track.

Heating and Ventilation

The difficulties of surface car ventilation in the winter time is to an extent bound up with the question of car heating. The use of the usual hinged or pivoted monitor window ventilators produces draughts. In some of the recent steam railroad passenger car designs ventilation is accomplished entirely by means of roof or special forms of monitor ventilator. The two Chicago companies have made many experiments on this subject and use several different types of ventilator, neither type being largely in use in other places. With the limited volume of air in proportion to door area and the frequent opening of doors it is a difficult problem to provide a system of uniform ventilation without draught and at the same time to furnish sufficient heat

It is recommended that the monitor windows be fixed and that ventilation be obtained from a sufficient number of automatic roof or monitor ventilators. These provide fixed openings for air to be admitted and discharged. Their use has demonstrated that the car temperature can be kept at the proper point, at the same time providing good ventilation.

In order to compare the Philadelphia standard car with other Philadelphia types and with cars of the four other cities, all of which are heated by electricity, a ready method is to divide the volume of air to be heated by the number of amperes of current represented by the rated capacity of the heaters used for this purpose. The result is the number of cubic feet of air to be heated per ampere of current. In the Philadelphia Pay-Within car this is 335 cubic feet per ampere as compared with 154 cubic feet for the 24-foot maximum-traction car and 131 cubic feet for the 20-foot single-truck (People's Traction) car. The smaller cars are well heated while the Pay-Within car is insufficiently heated. Comparative figures for other cars are as follows:

CAR HEATING

	Volume of Air to be Heated per Ampere (cu. ft.)	Number of Heaters per Car
Metropolitan	146	16
Third Avenue	149	16
Brooklyn	126	6
Chicago City	160	18
Chicago Railways	158	18
Boston	215	22
Philadelphia	335	6

The number of heaters in a car is important as affecting the distribution of heat throughout the car. It is recommended that the heaters in Pay-Within (E-44) type of car be doubled in number and in capacity in order to give the proper distribution and amount of heat.

Lighting

In the Philadelphia Pay-Within car there are eight incandescent electric lights inside the car arranged in three clusters in the ceiling. This is the same number and arrangement as in the small 20-foot single-truck closed car and also in the 24-foot maximum-traction car. In addition there is one lamp on each platform. The interior lighting of these cars compares with other cars as follows:

NUMBER OF LIGHTS INSIDE CAR

Metropolitan	16
Third Avenue	15
Brooklyn	16
Chicago	21
Boston	16
Philadelphia	8

The Philadelphia Pay-Within car lighting is manifestly insufficient and the number of lamps in the car should be doubled. The lighting will be better distributed by using single socket lamps placed in one row along the monitor ceiling and another row on each side of the lower deck. In order further to compare the lighting of these cars on a basis of ready approximation, the volume to be lighted inside of

the car is divided by the number of lamps times 16 candle power, which will give the number of cubic feet to be illuminated per candle. This figure for the Pay-Within car is 12.2 cubic feet as compared with 8.4 cubic feet for the 24-foot maximum-traction double-truck car and 7.1 cubic feet for the 20-foot single-truck car. Comparison with the car lighting in other cities is as follows:

CAR LIGHTING

	Volume of Space to be Lighted per Candle (cu. ft.)
Metropolitan	6.9
Third Avenue	7.1
Brooklyn	5.9
Chicago City	4.5
Chicago Railways	4.3
Boston	7.3
Philadelphia	12.2

From 1 to 2 lights should be used on each platform depending on its size, and additional lights are needed for the headlight and the independently illuminated destination signs.

Advertisements

The Company contracts with a car advertising company for the advertising space on the side cove of lower decks of cars, using the end space for its own advertisements and the outside dash for special line attractions. This is the usual arrangement in the other cities named.

Conductor's Signals

Signals from passengers to conductor are not used in Philadelphia, while in the New York, Chicago and Boston cars push buttons are provided on the side posts, connected to a bell or buzzer on platforms. This is a matter of convenience for the passengers, which, in the case of car without bulkhead doors, is only of value when the car is crowded, as otherwise the conductor can readily be notified. The signal from conductor to motorman is a hand bell-cord in the middle of the car.

Braking

The Philadelphia cars of all types larger than the single-truck car have both air and hand brakes, the hand brakes being controlled either by vertical wheel or horizontal ratchet handle. The single-truck cars have hand-brakes operated by horizontal ratchet handle.

The sanding device used on the Philadelphia car is simply the old fashioned bucket of sand and scoop, the sand being shovelled out by the motorman and thrown into a hopper. On the single-truck type of car there is apparently no sand equipment used. In case of emergency stop on slippery rail the motorman has no time to pick up the sand scoop as both hands are employed with controller and brake. Consequently in the interest of safe operation all cars should be equipped with sanding device. Either the mechanical or the air sander is satisfactory. The New York, Brooklyn and Boston cars have mechanical sanders, and the Chicago cars, air-operated sanders.

Fenders

The Philadelphia cars are equipped with an extension fender constructed by the Company consisting of a pipe frame enclosing a rope net, the fender being hinged to the car by brackets and suspended by chains from the dash. The fender has a projection of 29 inches from the bumper. These fenders are fairly effective for extension fenders, but are poorly maintained and are unsuitable for operation in the congested streets of large cities where the use of an automatic wheel guard has been found to be highly effective. The projecting brackets attached to the car for the support of these fenders are also objectionable, as they afford foot-hold for "hangers-on" at the rear end. A somewhat similar type of fender is used on the Boston car and most of the Brooklyn lines. The practice in New York and Chicago and in the down-town districts of Brooklyn has been to abandon the projecting fender and in its place to use a patented automatic drop wheel guard. The efficiency of this device as compared with the projecting fender has been demonstrated by a series of interesting tests made by the Public Service Commission for the First District, State of New York, and by the results of operation on the New York and other systems. It is recommended that wheel guards of this type should generally replace in Philadelphia the projecting fender for moderate speed operation where pavement and track conditions permit, and that for high speed operation in the suburbs an approved projecting fender be used in addition.

Draw Bars

The draw bars used on the Philadelphia car are of the plain spring non-telescoping type, the projection of the drawhead beyond the bumper being 7 inches and that of the bar 11 inches. This form of draw bar is objectionable, as in cases of persons struck, even if the fender acts efficiently, the projection of draw bar or head will often cause injury. On the rear of the car it affords standing space for "hangers-on."

The cars of New York, Brooklyn and Chicago have the fixed jaw type of draw head with removable bar, which is usually carried under the side sill. It is recommended that this flush type or a telescoping type of draw head and draw bar be used on the new standard Philadelphia car, and also on the present cars upon the adoption of wheel guards.

Bumper Guards

The Philadelphia Pay-Within car has dash shields in order to prevent riding on the bumpers, outside of the dash. These dash shields have become quite general and are found on standard cars of practically all of the other cities named.

SUBWAY-ELEVATED CARS

Comparison of General Design with Other Latest Types of Subway Cars

The subway-elevated car of the Philadelphia Rapid Transit Co. is the standard adopted at the opening of the Market Street elevated and underground railway in 1907, when 100 cars were purchased. This car is of first-class design and construction and compares favorably with the latest type of high-speed urban passenger car used in other places. For purpose of comparison, tabulated statements have been prepared showing the general design and details of this car as compared with the latest types of subway cars adopted by the Hudson & Manhattan R. R. Co. (Hudson Tunnel) and the Interborough Rapid Transit Co. of New York City, which latter types were adopted in 1909, or two years later than the Philadelphia car. The need for additional equipment on the Philadelphia subway-elevated line is discussed in another portion of this report.

Dimensions

The general dimensions of these cars are as follows:

	Length Over Corner Posts	Length Over Bumpers	Width Over All
Philadelphia	40′ 7″	49′ 7″	8′ 9″
Hudson Tunnel	38′ 3″	48′ 2″	9′ 0″
Interborough	39′ 4″	51′ 0″	8′ 10″

Weight

The fully equipped cars weigh when empty:

	Weight	Weight per Seat
Philadelphia	74,000 lbs.	1542 lbs.
Hudson Tunnel	70,100 "	1593 "
Interborough	73,400 "	1412 "

Electric Motors

The electric equipment of the Philadelphia car comprises two motors with a total rated capacity of 250 H. P. All cars in the train are motor cars, due to the necessity of obtaining traction on the heavy grades of the exposed inclines at the ends of the subway. This motor capacity is less than that of the Hudson Tunnel car which has two motors of 320 H. P. total, or of the Interborough car with two motors of 400 H. P. In the Hudson Tunnel train all cars are motor cars, and in the Interborough train two out of three are motor cars, three out of five, five out of eight and seven out of ten, a proportion varying from 60 to 70 per cent., and giving approximately, from 30 to 35 per cent. traction, which is sufficient for the slight grades encountered.

Trucks and Brakes

In the case of the last two companies, the two motors on each motor car are mounted on one truck, the other truck being of lighter design. In the case of the Philadelphia car, the trailer truck is of the same design as the motor truck. The other truck characteristics are in general the same for all three roads, all of which also use the Westinghouse automatic air brake with graduated release.

Comparison of Details of Subway Cars Affecting the Travelling Public—Signs

No line or destination signs are used in the Philadelphia subway-elevated car as there is only one line and destination. The Hudson Tunnel also uses no car signs but has electric signs on the station platforms showing the destination of the approaching train. The sign on the Interborough car is a sheet-iron slide in the front and rear side windows, reading both inside and outside of the car. Colored marker lights are also used on the hood of the front car to designate the line.

Platforms

The length of platform varies from 2′ 11″ on the Philadelphia car to 3′ 2″ on the Hudson Tunnel car, and 4′ 10″ on the Interborough car. The long platform used by the Interborough car is desirable, as it permits the movement of two passengers abreast through the platform door, this being possible also through the bulkhead opening. With the subway-elevated type of car, the question of the overhang and structural difficulties of the long platform are avoided, due to the sills being continuous to the end of the platform, making the platform practically a part of the car body. The platform of the Philadelphia car (when empty) is about 6 inches above the level of the station platform. The height of platform of the Hudson Tunnel car (when empty) above the station platform is approximately 3 inches, and the Interborough car and station platforms are about on the same level.

It is recommended that in the design of future Philadelphia subway-elevated cars, longer platforms be adopted, with side platform door openings of at least 47 inches. It would be expensive and difficult either to lower the platform of the present cars or to raise the station platforms from 4 to 6 inches, and it would seem that the advantages gained would not warrant the outlay. There is no necessity for the step, which to some extent obstructs the free movement of passengers.

Doors

In all three types of car, a single sliding platform door is used, the opening in the Philadelphia car being 30¼ inches, in the Hudson Tunnel car 35 inches, and in the Interborough car 47 inches. The Philadelphia and Hudson Tunnel car doors are operated by air, and the Interborough door by hand lever, by the guard. Each of the three cars has single, sliding doors in the center of the side of the car. The Philadelphia center door is 37 inches wide, the Hudson Tunnel 44 inches and the Interborough 48 inches. In the latter case a pipe stanchion barrier divides the opening into two spaces, each of sufficient width to permit the free movement of one line of passengers. In all three cars the side door is pneumatically operated by the guard. The end platform door in these cars is a single, sliding door operated by hand by

the guard. In the Philadelphia car the opening is 19¾ inches, in the Hudson Tunnel car 24½ inches and in the Interborough car 29½ inches. This door ought to be at least 23 inches in width in order to permit of free movement of passengers. The width of bulkhead opening is 38¼ inches in the Philadelphia car, 46 inches in the Hudson Tunnel car and 42½ inches in the Interborough car. This opening, in order to permit the movement of two passengers abreast, should be 46 inches in width.

Seats

As the traffic on the Philadelphia subway-elevated line, and in fact on any subway or elevated line, consists largely of rush-hour business, necessitating the rapid movement of large numbers of passengers, it is essential, in order to maintain short headway between trains, to cut down the time of stops at stations to a minimum. This requires quick loading and unloading, effected by the use of center doors supplementing the platform doors. Both the use of center doors and the desirability of free movement through the car prevent the use of cross seats. The Philadelphia car has a seating capacity (based on from 17 to 18 inches per seat) of 48, as compared with 44 for the Hudson Tunnel car and 52 for the Interborough car, the latter being exclusive of four single folding seats in front of the center doors. The seats and backs of the Philadelphia car are of spring rattan and are comfortable seats of this type, the backs being 15 inches high. The Hudson Tunnel car has a novel feature of partitions dividing the longitudinal seats on each side into six sections, some sections seating three and some four passengers. These partitions are of sheet metal, supported in front by white enameled pipe stanchions, which serve as grab-handles for passengers. This method of partition is also used on some European cars and seems to possess advantages where longitudinal seats are a necessity, as it tends to prevent overcrowding of the seating space and also adds to the comfort of the seats.

Standing Room

On account of physical limitations of the car equipment and track system of a subway, it is essential that a large amount of standing room be provided to accommodate the excessive overloads at rush hours. In the Philadelphia car, including platforms, there is capacity for 59 passengers, allowing standing space of 4 square feet per passenger, as compared with 56 for the Hudson Tunnel car and 67 for the Interborough car. This would provide total standing and seating capacity of 107 for the Philadelphia car, 100 for the Hudson Tunnel car and 119 for the Interborough car.

Steadying Methods

The Philadelphia car contains 47 leather hand straps in the usual position, with 4 grab handles on the side doors. The Hudson Tunnel car, in addition to white enameled pipe stanchions at each seat partition has a horizontal, white enameled pipe hand-rail between stanchions at a height of six feet. In the Interborough car, there are used 60 white-enameled, iron hand-holds, spring hinged, in the usual position of hand straps, together with four stanchions at the center barriers.

These rails and pipe stanchions, and hinged hand-holds, seem to be excellent devices.

Window Openings

In the case of the Philadelphia car and the Interborough car, the side windows open by lowering the upper sash. In the Hudson Tunnel car the side windows are fastened shut, the entire ventilation being provided by openings in vestibule doors and by monitor ventilators. In this case the car acts as a plunger in the circular tube and consequently creates an air pressure, admitted through front and monitor openings, which eliminates the necessity of using the side windows. Due to the high speed of subway cars in any form of tunnel, the ventilation is readily obtained by opening the end doors or through the monitors. In the case of the Philadelphia car the monitors are very small, the side area being only 1.3 square feet as compared with 5.1 square feet for the Hudson Tunnel car and 13.1 for the Interborough car. Patent ventilators, however, are used in the monitors and provide, with the end doors, sufficient ventilation.

Heating

The Philadelphia car contains 18 heaters inside the car and 2 in the cab. This heating referred to the measure used for surface cars, would be equivalent to 127 cubic feet of air heated per ampere, which is a sufficient amount and distribution of heating for these cars for subway or elevated service. This is practically the same heating effect as that obtained in the Interborough car. The Hudson Tunnel car has no heaters installed, as the deep tunnel temperatures do not require them.

Lighting

In the Philadelphia car there are 21 lamps, spaced singly in the center and along the sides of the lower deck in the interior of the car, with 2 lamps on each platform. This provides a sufficient amount of light measured by the standard mentioned, and almost as much as in the Hudson Tunnel and the Interborough cars.

Advertising

The usual advertising spaces are rented to a car advertising company and the end space is used by the railway company.

Conductor's Signals

As a safety measure and to expedite starting of trains, the Interborough cars are equipped with an electric signalling device which lights a lamp in the motorman's cab when all side doors are closed. The Philadelphia cars are equipped with a similar device for ringing a buzzer when the doors are closed, although this is not in use at the present time, due, it is understood, to the short length of the train. As the length of the train is increased, however, the use of this device will shorten the time of stops at stations.

Bumpers

On the Hudson Tunnel and Interborough cars the bumpers are provided with an anti-climbing device to prevent telescoping of the cars in collisions. It is understood that this will be adopted on the Philadelphia subway-elevated cars.

RECOMMENDATIONS AS TO CARS

New Standard Surface Car

For the purpose of this report, it is assumed that the new standard surface car for use in Philadelphia will be a 28-foot, two-motor, cross-seat pre-payment car with 5′ 6″ platforms (inside) and with windows capable of large opening to make it suitable for both summer and winter operation. If the width of this car were 8′ 4″, with skeleton sides and 34-inch cross seats, it would permit of an aisle 28 inches wide.

A comparison of the operation of this car with reversed, center-bearing, maximum-traction trucks, but without projecting fender, on the Company's standard track curve for right-angle intersections of 50-foot streets, shows that on the outside of the curve the overhang would be approximately 18 inches less than the present fender clearance of the Pay-Within car, and that the clearance of the bumper of the proposed car from the outside curb, which determines the width of free driveway, would be 7′ 10″ as compared with 6′ 6″ under present conditions. On the inside of the curve with the proposed car, there would be 6 inches additional overhang, but as this gives a clearance of 13′ 6″ from corner of building line there would thus be 18 inches of clearance from a curb of 12-feet radius. It will therefore be seen that clearance conditions would be improved with this design of car which would have sufficient length of platforms to provide a proper system of fare pre-payment. It may even be practicable to use a car 30 feet in length, or even longer on certain lines.

While such a car is assumed as the future standard motor car, it may be practicable to show marked economy over present operation and work out the most efficient method of handling both its rush-hour and non-rush-hour business with a combination of three classes of cars, as follows:

1. Use for all-day operation on lines of heaviest traffic, the proposed standard 2-motor, double-truck car as far as the number purchased will go, and beyond that the present 4-motor double-truck cars.
2. Use for all-day operation on lines of light traffic not running through the delivery district, the 2-motor single-truck cars now owned.
3. Use as far as practicable for rush-hour tripper service, a combination of the present 4-motor double-truck car with a specially designed light-weight trailer of large capacity.

It is believed that the use of trailers, if found to be generally practicable in Philadelphia, would permit the Company to handle the additional rush-hour business on the most economical basis. The possibility of providing for rush-hour business of enormous proportions in comparison with middle-of-the-day business is well shown in the train operation of subway and elevated lines. Limitations, both of finance and of track and crossing capacity, point to the necessity of using surface trailer operation in rush hours for the congested section of large cities.

Details of New Standard Surface Car Especially Affecting the Travelling Public—Signs

It is recommended that there be made an entire rearrangement and standardization of the system and nomenclature of line and destination signs. Transparent line signs should be used on the front, rear and sides of the monitor, illuminated from the car. A destination sign, independently illuminated, should be placed in the center of the front and rear vestibules directly under the hood.

Steps

The height of first step should be from 14 to 15 inches, second step 13 inches, and third step from 9 to 10 inches. The first step should be folding or protected. It should be at least 11 inches wide and should be provided with a safety tread.

Doors

Folding platform doors should be mechanically operated by motorman or conductor. This mechanism should be so simple that in emergency a passenger can release the door. The entrance on the rear platform and exit from front and rear platforms should be at least 23 inches in the clear.

There should be no bulkhead doors, and the entrance and exit through the bulkhead, if separated, should each be at least 23 inches in the clear.

Suitable grab-handles should be located on the vestibule corner post at the front exit and on the body post at the rear exit, with a pipe stanchion from step to hood on the rear platform separating the entrance and exit.

Fare Collection

The conductor should be located on the rear platform behind a suitable separating rail or steadying device.

Seats

Cross seats should be 34 inches long and longitudinal seats 36 inches. A 28-foot car with 16 cross seats and 4 longitudinal will seat 40 passengers. The seats should be 18 inches above the floor and 16½ inches wide, with a slope of 1½ inches for cross seats and 1 inch for longitudinal seats. The height of backs should be 18 and 14 inches respectively, and the slope of backs 4 and 3 inches. Spring rattan properly shaped should be used for both seats and backs. Cross seats should be spaced approximately 30 inches from center to center.

The standing room in this car, allowing four square feet of aisle and platform space per passenger, will accommodate 36 passengers, making a total capacity of 76.

For the use of standing passengers there should be provided grab-handles or hand-holds on the backs of each cross seat and the usual hand rail straps.

Windows

Full opening should be given to vestibule windows. Monitors should be fixed shut and there should be provided sufficient roof or monitor automatic ventilators.

Heating

There should be installed, 16 heaters of a total rated capacity of 12 amperes.

Lighting

Twenty 16 c. p. incandescent lamps should be used, of which 15 would be inside of car, 1 on each platform, 2 for destination signs and 1 for headlight. The interior lights should be arranged in single sockets, 5 on the ceiling and 5 on each side of the lower deck.

Conductor's Signals

There should be a push button on each side post with electric bell or buzzer on platform.

Braking

Both air and hand brakes should be used, together with mechanical sander.

Fenders and Wheel Guards

Projecting fenders should be used only on cars operating on high speed lines. Automatic wheel guards should be installed on all cars.

Draw Bars and Bumper Guards

It is recommended that if practicable a fixed flush draw head with movable draw bar be used, otherwise a draw bar of the telescoping type. No projection of any device beyond the bumper should be permitted and dash shields should be used, thus preventing "hanging on."

Recommended Changes in Pay-Within Cars—Signs

It is recommended that the same system and type of illuminated car signs be used as for the new standard car.

Doors

A simple mechanical passenger's release for sliding platform doors should be installed for use in emergency. This should be under the proper restriction of the car operatives.

Seats

Eight cross seats removed from cars in their reconstruction as Pay-Within cars should be replaced and located either all on one side or 4 on one side and 4 on the other, diagonally opposite, at the same time widening the inside of the car alongside of the cross seats by removing the side linings between posts if feasible. These cross seats, together with the use of a more comfortable, higher, spring rattan back for the longitudinal seats and proper sloping of longitudinal seats and backs, will much improve the comfort of these cars. This arrangement will give satisfactory standing room for 34 and a total car capacity of 74.

Ventilation

An approved type of automatic roof or monitor ventilator should be installed.

Heating

There should be added 8 electric heaters of total capacity of 6 amperes, giving a total of 16 heaters with a rated capacity of 12 amperes, thus doubling the heating capacity.

Lighting

Twenty 16 c. p. incandescent lights should be used with the same arrangement as recommended for the standard car. This is twice the present illumination.

Braking

A mechanical sander should be installed.

Fenders and Wheel Guards

Automatic wheel guards should be installed and projecting fenders used only on high-speed lines.

Draw Bars

The same type of draw head and draw bar should be used as recommended for the standard car.

Recommended Changes in Other Surface Cars

All surface cars should be equipped with mechanical sanders, automatic wheel guards and non-projecting draw heads as recommended for standard car. Projecting fenders should be used only on high-speed lines. All cars should be put through the paint shop and thereafter painted and varnished on a definite schedule.

Recommended Changes in Subway-Elevated Cars

The present subway-elevated cars are of satisfactory design and no changes in them are recommended. In the purchase of future cars, however, a few suggestions have been made above as to improvements of details.

Investment Required for Additional Equipment

The car requirements for recommended service are calculated without reference to the question as to whether or not it is economical for the Company to continue in operation the present number of single-truck and maximum-traction cars. All available single-truck cars of fairly good type are assumed to be retained and the remaining service provided by as many maximum-traction and double-truck cars as are on hand together with an additional number of new large cars which it will be necessary to purchase. It is assumed that the Company will determine how long it can afford to operate the single-truck and maximum-traction cars retained and will gradually replace many of them with new cars.

This plan, based on the recommended service required for October, 1910, would involve the purchase of 489 large cars, as of October, 1910. The addition of cars requires equivalent additional capacity of power house, feeder system, car houses and shops and these should be designed and ordered from one to two years in advance of the need to allow for time of construction. Without making allowance for the additional equipment needed to provide for increase of traffic from

October, 1910, until such time as the new equipment would be available, an estimate of expenditure for the 489 additional cars needed at October, 1910, has been prepared. These cars, if motor cars, with equivalent additional capacity of power house and feeder system, car houses and shops, will cost approximately $15,000 per car for 465 "operating" cars and $6,300 per car for 24 "shop" cars, or would involve a total expenditure of about $7,126,000. The investment would be less if the general use of trailers in Philadelphia proves to be practicable. The recommended changes in the present surface car equipment involve an expenditure not to exceed $500,000.

The service recommended for the subway-elevated line would involve the purchase of 12 additional cars. The present 120 cars are needed for operation. The 12 additional cars are required as reserve, and at $12,000 per car would represent an investment of $144,000.

These recommendations for additional equipment needed at October, 1910, therefore involve a total expenditure of approximately $7,770,000, and are exclusive of betterments and extensions of track and line. With a normal rate of growth, at least 100 additional cars per year with power and storage capacity will be needed to provide for additional traffic.

OPERATING STATISTICS

For the purpose of investigating the progressive relation of service to traffic during a period of years, there have been collected and compiled statistics covering the traffic, receipts, service and operating expenses for the fiscal years ending June 30, 1907 to 1910, inclusive. The business of 1909 was affected by a strike from May 29 to June 6, and that of 1910 by a strike from February 19 to April 2. The traffic of the surface system in 1908 was largely affected by the inauguration of the subway-elevated service, and the year 1908 also shows the result of the severe business depression. The figures, therefore, for the year 1907 only, represent approximately normal conditions in Philadelphia. While the primary statistics for the last two years are affected by the strikes, no extraordinary strike expenses are included in the operating expenses, and in general the service was reduced as well as the traffic.

The primary information used in these statements was secured from the Philadelphia Rapid Transit Company. This has been entirely rearranged to show traffic by groups of lines and to furnish a study of the service by various pertinent units. These derived or per unit figures show various measures of the amount of traffic and quality of service.

Groups of Lines

In order to ascertain the relative gain or loss in business and quality of service the 89 operated lines are grouped as follows:

I. Double end lines running through the delivery district from north to south;
II. Lines terminating in the delivery district;
III. Crosstown lines which do not run into the delivery district;
IV. Suburban lines.

The double end lines are further classified by combining those which run to the northeast, to the north suburbs, and to North Philadelphia, which is defined as the thickly settled section of the city between Front Street and the Schuylkill River, south of Hunting Park, and north of Cherry Street.

The lines terminating in the delivery district are classed as coming from the northeast, the north suburbs, North Philadelphia, South Philadelphia and West Philadelphia.

The crosstown lines are grouped by northern, southern and western sections.

The relative importance of the various groups of lines and the extent to which they have been affected by the adverse conditions of the past three years is shown by the following:

	Ratio to Total Passengers 1910	Decrease in Passengers Carried From 1907 to 1910	Decrease in Car Miles Operated From 1907 to 1910
Double End Lines North and South	26%	19%	19%
Lines Terminating in Delivery District:			
From North and South	28	12	11
From West Philadelphia (surface)	16	31	22
Crosstown Lines	20	12	19
Suburban Lines	2	10	13
Total Surface Lines	92%	18%	17%
Subway-Elevated	8	......	......
Total	100%	12%	13%

The greatest rate of decrease in three years was 25% on the crosstown lines in South Philadelphia. The lines to the northeast decreased about 24%. The only group of lines showing an increase is that from the north suburbs to the delivery district, which increased 4%.

Of the lines which run through or into the delivery district, except subway-surface lines, the following alone show increases:

INCREASE OF PASSENGERS.

Willow Grove, 4 and 8	5.0%
Willow Grove, 13 and 15	4.5
Pelham	2.1
Wayne	5.6
Continental-Nicetown	3.6

The West Philadelphia lines were all greatly affected by the opening of the subway-elevated line and by changes in route.

Of the crosstown lines, except in West Philadelphia, only the Erie and Allegheny Avenue lines show increase.

Every suburban line, except Hatboro and Middletown, carried fewer passengers in 1910 than in 1907.

The average number of passengers carried per day for 1910 with the strike period deducted, compares with the average per day for 1907 as follows:

DAILY PASSENGERS FOR 1910, COMPARED WITH 1907

	Increase	Decrease
Double End Lines	—	13.9%
Lines Terminating in Delivery District:		
From North and South	......	4.3
From West Philadelphia	......	25.6
Crosstown Lines	7.6%	......
Suburban Lines	1.9	......
Subway-Elevated	685.0	......
All lines	......	3.2%

Passenger Receipts

The system of fares has undergone important changes since 1907. In that year the Company sold six tickets for 25 cents; free transfers were issued on cash fares or tickets at many points of intersection, and at others 3-cent exchange tickets good until used were sold. In 1908 the sale of six-for-a-quarter tickets was discontinued, a time limit was enforced on the exchanges, and transfers were issued only on cash fares. This has resulted in an increase in average rate of fare, and therefore the decrease in passenger receipts is not so great as in total passengers carried, being only 8.0% for the surface lines and 0.6% for the entire system.

The passenger receipts of the surface system increased from 22.2¢ per car mile in 1907 to 24.8¢ in 1910. The following lines only, show decrease in receipts per car mile during this three year period:

Receipts Per Car Mile

	1907	1910
19 & 20 Sts.	43.0¢	41.6¢
Passyunk	18.9	16.9
Chestnut	21.3	21.1
Darby	23.0	22.7
Lancaster-Haddington	28.6	27.7
Haddington-Haverford	27.8	25.5
63 & Vine	32.9	26.1
Chester Avenue	20.2	10.7
Point Breeze	11.4	9.9
Lombard & South	23.5	22.2
Callowhill	13.1	12.1
Jefferson & Master	20.1	19.5
Chester	11.6	10.5
Lansdowne	13.9	12.9

Thirty-three lines out of the total of 89 have receipts per car mile in 1910 greater than the average of 24.84¢. Lines having the largest receipts per car mile in 1910 are:

17 & 18 Sts.	45.2¢
12 & 16	42.4
19 & 20	41.6

Twelve lines have receipts less than 14¢ per car mile, which represents the average cost of operation without taxes in 1910 as reported by the Company. It is inaccurate to deduce the result that these lines are all operated at a loss, as this depends somewhat on the amount of transfer business or "paper" carried by these lines which does not show in the cash receipts.

The passenger receipts per mile of route were $14,920 for the surface system in 1910. The lines to South Philadelphia produced the largest earnings per mile of route, amounting to $28,800. The long lines from the north suburbs to the delivery district produced $11,200 per mile and the suburban lines produced only $2,738 per mile. The subway-elevated earned $98,900 per mile of route in 1910.

Express and Freight

The Company for several years has been doing a small miscellaneous business in the way of mail, newspapers and milk. In the fiscal year 1910 it established facilities for handling express and small

freight principally to points on the outlying lines, with a central freight house at Front and Market Streets. In 1909 the Company undertook the handling of ashes collected in the central portion of the city. The ashes are delivered by wagons on dumping floors from which they are handled by car to places of deposit in the outskirts.

Car Mileage

While the total passengers carried on the surface system decreased by 18.3% from 1907 to 1910, the Company decreased its car mileage by 17.4%. The greatest reduction was on the group of double end lines running from Northeast to South Philadelphia, which were more seriously affected by the strike. On the following lines only, was the service increased:

INCREASE OF CAR MILEAGE FROM 1907 TO 1910

Fox Chase	4%
Pelham	4
Chestnut Street (change of route)	83
Erie Avenue	188
Allegheny	49
Doylestown	2
Bala	21

and all lines entering the subway.

The mileage of trailers in 1910 constituted only 0.1% of the whole; the mileage of freight cars 0.06%; that of mail cars 0.39%. The subway-elevated line carried 8% of the passengers and operated about 6% of the car miles. The Company considers that 0.52% of the car mileage was non-revenue producing, this being the mileage of cars from the barns to the nearest points on the lines on which they run.

The subway-elevated line operated a somewhat less proportion of total car hours (3.75%) than car miles on account of its higher speed.

Operating Expenses

With a decrease from 1907 to 1910 of 18.3% in passengers and 8.0% in earnings, the operating expenses of the surface system decreased 6.8%, the details of which, as reported by the Company, by groups of operating expense accounts, are as follows:

DECREASE OF OPERATING EXPENSES OF SURFACE SYSTEM FROM 1907 TO 1910

Maintenance of Way, Structures and Line	30.9%
Maintenance of Equipment	2.9
Operation of Cars	8.5
Power, including Maintenance (Increase)	24.9
General Expenses	4.6
Total Operating Expenses	6.8%

The expenditures for current maintenance in 1910 compare favorably with the average of other large street railway systems, but no provision has been made for extraordinary renewals or reserves. The large decrease of Maintenance of Way, Structures and Line from 1907 to 1908 is partly caused by the release of the Company from paving requirements under the contract with the city which went into effect in that year, and which provided for the payment to the city of a lump sum for paving now included in taxes.

The only maintenance account showing an increase is that for Motors. Under Operation of Cars, the Platform Wages and Depot

Expenses have decreased as have also Car-house Men, Switchmen, etc., and Miscellaneous Expenses. Practically every item of cost of power has increased from 20 to 40%. Items under General Expenses, Salaries, Legal Expenses, Secret Service and Miscellaneous have increased, while Office Expenses, Accidents, Insurance and Engineering have decreased. The large decrease in Insurance is probably due to an unusual amount having been set aside in 1907. The total maintenance both in per cent. of gross earnings and per car mile declined in 1908 and 1909, but increased in 1910. Operation of Cars and Power steadily increased. General Expenses declined in 1908 and 1909, but rose in 1910 above 1907.

Including the subway-elevated line the operating expenses of the entire system increased 5.6% against a decrease of 0.6% in passenger receipts.

While the operating expenses of the surface system are reported as about 55% of the gross earnings in 1910 those of the subway-elevated line are reported as only about 36%, the corresponding figures per car mile being 14.04¢ and 12.25¢. This difference is partly a matter of bookkeeping, accounted for by the fact that the Company does not apportion joint general expenses between the surface and subway-elevated systems.

Income Account

The income account shows that while the passenger receipts decreased 8.0%, miscellaneous business such as handling milk, freight, city ashes, newspapers and advertising, was developed sufficiently to reduce the decrease in total gross earnings to 6.6%. The net earnings of the surface system decreased 6.3% in three years. The net earnings of the surface and subway-elevated systems combined show an increase of 4.2% in three years, having been as follows:

Net Earnings of Entire System

1907	$8,167,368
1908	8,677,108
1909	9,306,386
1910	8,510,833

Taxes and Licenses increased 40.1% from $1,120,683 in 1907 to $1,569,858 in 1910. This large increase was principally due to the fixed payment to the city of $500,000 per year provided by the contract between the City and Company which went into effect in the fiscal year of 1908, this payment being in lieu of previous paving requirements and of car licenses, which in 1907 amounted to $120,370. The United States excise tax of $78,428 was paid for the first time for 1910.

Interest and Rentals

Interest and Rentals increased 11.8% from $7,488,958 in 1907 to $8,374,463 in 1910.

Deficit

The deficit reported by the Company for each year without allowance for depreciation, extraordinary renewals or other reserves, is as follows:

Deficits from Operation

1907	$ 364,048
1908	92,049
1909	224,270
1910	1,329,723

The deficits for 1909 and 1910 were due largely to the strike of seven days' duration in 1909 and that of forty-four days in 1910, and the deficits for those years do not include extraordinary strike expenses.

Surface Operating Statistics

Important operating statistics are shown in the tabulated statements of Volume II for the four years reported by the Company and have been combined in various interesting and instructive relations.

Referring to the traffic data it will be noted that the 3-cent exchanges were used by 42,467,617 passengers in 1910 whereas before the enforcement of the time limit they were used by 115,995,631 in 1907. The number of free transfers at the same time decreased 8.2% while the total revenue passengers decreased 19.8%. The deadheads or passes, representing complimentary passengers and employes, constitute an unusually small proportion, being about 0.6%. The fact that the average maximum cars operated (being the average for the year of the maximum number of cars in use at one time in each month) decreased less than the car miles indicates that base-schedule cars were taken off to a greater extent than were rush-hour cars. There has been a small increase in track mileage of 5.2 miles.

Surface Operating Statistics by Units

The average fare per revenue passenger including exchanges, increased gradually during the three years, from 4.26¢ to 4.88¢, while the operating expenses per revenue passenger increased from 2.38¢ to 2.76¢. The ratio of operating expenses to gross earnings declined from 55.1% in 1907 to 53.1% in 1908, and further to 50.7% in 1909, but rose to 54.9% in 1910.

Maintenance of Way, Structures and Line per mile of single track operated declined from $2,506 in 1907 to $1,714 in 1910, in part on account of the release from paving obligations. Maintenance of Equipment per average maximum car operated was slightly larger in 1910 than in 1907, but was about 10% smaller in 1908. The cost of power distributed increased from 0.55¢ per K. W. Hr. in 1907 to 0.72¢ in 1909 and 1910. Platform wages (motormen and conductors) have increased from 41.7¢ to 46.0¢ per car hour or 10.3%.

Free transfers were used by 15% of the revenue passengers in 1907, 18.5% in 1908, 13.5% in 1909 and 17.2% in 1910. Three-cent exchanges were used by 27.5% in 1907, 17.8% in 1908, 10.2% in 1909 and 12.5% in 1910.

The service has been such that the total passengers of all classes vary little per car mile, per car hour, or per round trip. The average speed has remained stationary at practically eight miles per hour. The average length of round trip has increased slightly from 12.3 to 12.5 miles. The power consumption per car mile rose from 2.3 K. W. Hrs. in 1907 to 2.7 K. W. Hrs. in 1910 due to increase in size and number of motors.

Subway-Elevated Operating Statistics

The subway-elevated operating statistics are chiefly interesting when compared with those for the surface system, the subway-elevated having been in full operation only two years. It will be noted that the passenger receipts are 34.0¢ per car mile against 24.8¢ for the surface system in 1910, and $4.40 per car hour against $1.98. The operating

expenses cannot be fairly compared in all particulars because the general expenses common to both systems have not been apportioned and because the subway-elevated equipment is new. The transfer passengers represent about the same percentage as on the surface system. The average schedule speed was 12.9 miles per hour in 1910 against 8 miles per hour on the surface. The current consumption was 5.3 K. W. Hrs. per car mile against 2.7 for surface cars, and 0.67 K. W. Hrs. per passenger carried against 0.45 K. W. Hrs. per passenger on the surface system.

Combined Operating Statistics

The statistics of the surface and subway-elevated systems combined show the effects of the addition of a rapid transit line. Interest and Rentals increased from 40.7% of gross earnings in 1907 to 45.3% in 1910, or from 1.8¢ per revenue passenger to 2.3¢.

The passenger receipts per revenue passenger have increased from 4.26¢ in 1907 to 4.90¢ in 1910 and per car mile from 22.3¢ to 25.4¢, this being principally due, however, to the change in fares. The ratio of operating expenses to gross earnings has decreased from 55.0% to 53.4% although there has been an increase per revenue passenger from 2.3¢ to 2.7¢. Taxes and Licenses were 8.5% of gross earnings in 1910, or 0.43¢ per revenue passenger.

Method of Bookkeeping

As the purpose of this report did not cover the Company's financial operations no audit was made of the books and accounts. In presenting these statistics of cost of operation as bearing on character of equipment and service, it should be noted that for the year 1907 to a large extent, and also for 1908, the operating expenses shown in the reports furnished by the Company are incomplete and somewhat misleading. The following quotation as to this method of bookkeeping is from the City Controller's report of examination of the books, accounts and vouchers of the Philadelphia Rapid Transit Company for the year ending June 30, 1908:

> "The system of bookkeeping adopted by the Philadelphia Rapid Transit Company is to apportion a certain percentage of the passenger receipts to the principal operating accounts of Maintenance of Ways and Buildings, Maintenance of Power, and the percentage adopted is divided among the minor classifications of these two principal accounts, and if the results of this percentage charged does not, at the end of the year, equal or it exceeds the percentage appropriated to the principal accounts, the differences are charged directly to Profit and Loss, and not debited or credited to Operating.
>
> "A readjustment of these accounts, bringing them into Operating Account, where they properly belong, results in an increase in the deficit shown by the published report, of $125,873.93, making the total deficit for the year $217,922.71."

It is understood that for the year 1907 the operating expenses charged to profit and loss were larger than the amount as stated for 1908, including not only the accounts mentioned by the Controller as above, but also an expenditure for injuries and damages amounting to over $500,000.

Comparative Operating Statistics of Large American Street Railway Systems

In order to determine the character of service given the Philadelphia traveling public by its surface street railway system, tabulated statements are included in Volume II making comparisons with the surface systems of four other large American cities, New York (Manhattan and Bronx), Brooklyn, Boston and Chicago. Three of these cities are larger in population than Philadelphia, and one smaller. In all of the other cities, the operations of the companies are subject to regulation by governmental authority. This in the case of the New York and Brooklyn companies, is by the State of New York's Public Service Commission of the First District, and in Boston, by the Massachusetts Railroad Commission. In Chicago the companies are subject to regulation either by the City Council or by its representative, the Board of Supervising Engineers. Consequently, the character of facilities and service in these four cities would be expected to be as good as practical and financial limitations permit. It is understood that the companies in all of these cities are in good financial condition except those in New York City, most of which are in the hands of receivers.

While statistics are shown for the surface systems only, it should be kept in mind that in all of these cities and especially in New York, Brooklyn and Chicago, there is a large proportion of subway and elevated railway mileage accommodating the long distance, high-speed traffic, this proportion being much larger than in Philadelphia. The suburban lines of the steam railroads supply Philadelphia to an extent with this high-speed service to the outlying districts.

The subway and elevated lines relieve the rush-hour congestion on the surface-lines, as the proportion of rush-hour business carried is greater than on the surface lines. This is due both to the desire of the regular night and morning patrons to save time of transit even at the expense of a transfer or walk at the terminus of their journey, and also to the ability of the company by train operation to add extra cars to accommodate this rush-hour traffic without increasing trainmen, operating expenses and track congestion in proportion to the number of cars added as would be the case with single surface motor cars. A return to the trailer or two-car train would in like manner tend to increase the ability of a surface system to give better rush-hour service.

Population

The population served by the surface systems of each of these cities is as follows:

	Population Served (U. S. Census) 1910	Increase over 1900 Population	Per Cent
New York	2,762,522	711,922	34.7%
Brooklyn	1,634,351	467,769	40.1
Boston	1,043,546	176,646	20.4
Chicago	2,185,283	486,708	28.7
Philadelphia	1,604,000	270,300	20.3

It will be noted that the Boston population served is considerably less than Philadelphia; Brooklyn about the same; and Chicago and New York much greater. New York City, being the center of a population of about 7,000,000, draws a large amount of traffic from the population outside of its own boundaries. Boston and Philadelphia are increasing in population at about the same rate and New York, Brooklyn and Chicago at a much larger rate.

The land area served with comparative density of population is shown as follows:

	Land Area Served (square miles) 1900	Density of Population Served (population per square mile) 1910
New York	62.59	44,000
Brooklyn	77.63	21,000
Boston	87.35	12,000
Chicago	179.58	12,000
Philadelphia	169.73	9,500

From this it will be noted that the Philadelphia and Chicago land areas are of about the same extent and more than twice as large as those of New York, Brooklyn or Boston. The density of population, however, in Philadelphia is considerably less than in New York or Brooklyn and slightly less than in Boston and Chicago, which are equal in density. The large area and small density of population in Philadelphia is due to the large thinly populated districts to the north and northeast which have been included, although the Company's lines do not cover them completely. If this territory, not entirely served, were eliminated, the density would equal or slightly exceed that of Boston and Chicago.

Interesting features in the comparison of these cities, and which have considerable effect upon distribution of population, are the comparative number of dwellings and the population per dwelling. These are shown, as per United States Census of 1900 (the 1910 figures not being yet available) as follows:

	Number of Dwellings 1900	Population per Dwelling 1900
New York	100,547	20.4
Brooklyn	113,973	10.2
Boston	117,205	7.4
Chicago	193,895	8.8
Philadelphia	249,589	5.3

It will thus be noted that Philadelphia far surpasses all other American cities in its number of dwellings and that its population per dwelling is about the size of the average family, while the average families per dwelling in the other cities vary from 1½ to 4.

Track

A comparison of the track mileage of surface and subway-elevated systems of these cities, is as follows:

	Surface Track (miles)	Subway and Elevated Track (miles)	Ratio Subway and Elevated Track to Total Track
New York	494.62	199.97	28.8%
Brooklyn	512.05	103.79	16.8
Boston	410.04	24.09	5.5
Chicago	572.93	149.22	20.7
Philadelphia	545.74	14.65	2.6

With regard to surface track, it will be noted that the New York, Brooklyn, Chicago and Philadelphia systems are approximately of the same size, that of Boston being somewhat smaller. The figures for New York are for both overhead and underground trolley and include the horse system; while those of the other four cities are for the overhead trolley system which outside of New York and Washington, is the American standard. The enormous investment required for the underground trolley system renders its use practically prohibitive at present rates of fare. Even if the investment could be supported at all, the system would be confined to central built-up portions of a city and extensions to the outskirts could not be made before the territory was completely developed.

An interesting fact bearing on the facility and efficiency of car operation and also on the cost of track maintenance, is the proportion of double track and single track operated, which is as follows:

	Proportion of Line Double Track
New York	87%
Brooklyn	96
Boston	85
Chicago	95
Philadelphia	42

The proportion of 42% of double track in Philadelphia is less than one-half of that in any of the other cities. Practically all of the single track, with the exception of occasional outlying suburban lines, is operated in one direction only. The large amount of single track in Philadelphia is caused by the narrowness of streets and is so distinctive that this method of operation of a single track on one street in one direction and a second track on the next street in the other direction is known generally as the "Philadelphia plan." Most of the north and south lines are located on this plan as also are most of the east and west lines, exclusive of those on a few wide thoroughfares such as Spring Garden, Arch and Market Streets, and wider avenues in the newer northern part of the city, such as Girard, Columbia, Lehigh, Allegheny, Erie, Germantown, Kensington and Frankford Avenues. Most of the lines in West Philadelphia have double track. The narrowness of streets entails comparatively slow speed, limits the size of the car and contributes to accidents. The large amount of single track with the consequent large proportion of track special work is expensive to maintain and does not serve the public so well as would double track of equivalent investment. It is one of the greatest handicaps of the Philadelphia surface system.

A comparison of the amount of track with reference to population and area served, is as follows:

	Population Served per Mile of Track	Miles of Track per Square Mile of Area Served
New York	5,585	7.9
Brooklyn	3,191	6.6
Boston	2,545	4.7
Chicago	3,814	3.2
Philadelphia	2,940	3.2

It will be noted that the Philadelphia system serves less population per mile of track than those of the three other larger cities, which means, conversely, that it has more miles of track per thousand of

population, and therefore provides a greater facility in this respect than is provided in the other cities except Boston. If subway and elevated mileage is added to these figures, Brooklyn has greater track facility than Philadelphia, but the latter is still ahead of New York and Chicago.

The track mileage in Philadelphia in relation to the extent of territory served is equal to that in Chicago, but less than that in the other three cities. Considering only, however, the built-up sections of these cities, it is probable that Philadelphia is served more fully than Chicago, as well as Boston and almost as well as Brooklyn.

In other words, the amount of track provided by the Philadelphia system for the population and extent of its territory compares favorably with the other cities.

Service

In a comparison of the service in these five cities, it should be remembered that the figures for New York will be qualified by the difference in population, the dense nature of the traffic and large investment per mile of track of the New York system. The Brooklyn and Chicago systems are believed to be more nearly comparable with that of Philadelphia.

Car Miles Operated

The most convenient unit of service is the number of miles operated by all of the cars of the system for one year. This unit of car miles has been generally adopted by the industry as a measure of service. It is not entirely satisfactory, due to the variation in size of the cars used. For example, the car miles operated in Philadelphia where only 36.7% of the total cars owned are double-truck cars, will not have the same significance as the car miles operated in Brooklyn where 89.5% of the cars owned are double-truck cars. In other words, a mile operated by an 18-foot single-truck car weighing 16,250 lbs. in Philadelphia, should not be considered strictly the same as a mile operated by a 55,650 lb. car in Boston. From the standpoint of service as determined by car headway, however, the unit possesses an absolute value, and in general is a convenient measure of comparative service. The car miles operated for one year by these systems are as follows:

	Car Miles	Car Miles Operated per Mile of Track	Car Miles per Capita
New York	68,960,734	139,000	25
Brooklyn	55,451,365	108,000	34
Boston	43,599,806	106,000	42
Chicago	81,477,682	142,000	39
Philadelphia	66,685,281	122,000	42

It will be noted that the Philadelphia company operates a considerably larger amount of service than Brooklyn or Boston; practically as much as New York, but falls far short of Chicago. It gives considerably more service per mile of track than Brooklyn or Boston, although less than New York and Chicago. From the standpoint of car miles per capita served, it is equal to Boston and exceeds New York, Brooklyn and Chicago, although in this latter particular the addition of the car service operated by the large subway and elevated systems of these three cities would reverse the relative showing.

Average Speed

The number of car miles operated per year divided by the car hours, which is another unit of service, being the number of hours all cars in the system are operated for the year, gives the average speed of the systems, as follows:

	Average Speed (miles per hour)
New York	7.43
Brooklyn	8.00
Boston	9.76
Philadelphia	7.96

From this it will be noted that the average speed in Philadelphia of 7.96 is practically the same as the 8.00 miles per hour in Brooklyn. The lower speed in New York is occasioned by the great density of street traffic and large number of stops per mile, while the higher speed of Boston is possible because of the surface-car subways in the congested section of the city, and the large amount of suburban mileage. One is impressed with the apparent slowness of operation of the Philadelphia surface cars, but due to the narrow streets and the corresponding increase of liability to accident from higher speed, it is believed not much net improvement can be made in this direction. Higher average speeds decrease the cost of car operation and amount of rolling stock necessary, besides tending to enlarge the traffic.

Average Length of Trip

A comparison has been made of the average length of car round trip of these systems which is practically double the average length of line or route operated, and is as follows:

	Average Length of Round Trip (miles)
New York	8.89
Brooklyn	8.38
Boston	9.24
Philadelphia	12.50

It will be noted that the Philadelphia trips or lines are practically 50% longer than those in the other cities with the exception possibly of Chicago, for which this and some other statistics were not available. While the length of trip is somewhat dependent on the area of territory served, it can be largely regulated by the management by turning back cars or lines both at the delivery district and at the point near the end of the line where the traffic falls off sufficiently. Excessive length of lines or trips is undesirable as it increases irregularity of car movement due to the greater liability of interruption. In another part of this report it is recommended that more turn-back points be established, both in the delivery districts and outskirts, which would not only reduce the average length of operating trips, but would also save car mileage. In this connection it should be noted that the length of time taken for the average round trip is 94 minutes in Philadelphia, compared with 56 minutes in Boston, 66 in Brooklyn and 72 in New York.

Average Maximum Cars Operated

Another unit, the average maximum cars operated, has been adopted by this firm to measure the amount of rush-hour or peak-

load car service furnished. This is obtained for any year by taking an average of the greatest number of cars operated at one time during each month. Certain factors of cost of operation, both of investment charges and operating expenses, vary with this unit. The maximum cars required for operation affect the amount of investment in rolling stock, power plants, car houses and shops, together with the expense of maintenance of equipment, cost of power and certain fixed costs of operation of cars. A comparison of the approximate average maximum cars operated by the various systems is as follows:

	Average Maximum Cars Operated
New York	2,464
Brooklyn	1,709
Boston	1,600
Philadelphia	1,776

Although the Philadelphia system operates approximately as many surface car miles as that of New York, the average rush-hour service is only about two-thirds as large, and while the Brooklyn and Boston systems do not operate nearly as many car miles as that of Philadelphia, their average maximum cars operated are almost as great.

Looking at the matter from another standpoint, the average car spacing for the maximum car operation or the maximum cars operated per mile of track, is as follows:

	Average Maximum Cars per Mile of Track	Population Served per Average Maximum Car Operated
New York	5.0	1,376
Brooklyn	3.3	956
Boston	3.9	652
Philadelphia	3.3	903

From this it is noted that for average maximum operation, assuming equal car spacing over the entire track system, there would be an average of one car every three-tenths of a mile of track in Philadelphia and Brooklyn, one every one-quarter of a mile in Boston and one every one-fifth of a mile in New York. From the population statistics it would appear that the number of maximum cars operated per thousand population is greatest in Boston and least in New York and Brooklyn although in the latter cases, as has been stated, the rush-hour traffic is largely taken care of by the subway and elevated systems.

These statistics indicate that the rush-hour service in Philadelphia is relatively less than that furnished in other large cities. In another part of this report, this deficiency of rush-hour service is treated more fully.

Seat Miles

A measure of the amount of service which takes account of the capacity of the cars operated, is the seat mile or the operation for revenue of one seat (seating space for one passenger), one mile. The total seat miles for one year have been calculated approximately for the Philadelphia surface system, for comparison with the actual figures for New York City, as follows:

	Seat Miles Operated	Seat Miles per Capita
New York	2,668,749,000	966
Brooklyn	2,495,508,000	1,527
Philadelphia	2,274,000,000	1,418

It will be noted that the Philadelphia system operates almost as many of these units of service per capita as Brooklyn and many more than New York, although in both of these other cities the surface cars are supplemented by extensive subway and elevated systems.

Seats per Car

The effect of the large proportion of single-truck cars in Philadelphia and the small proportion in Brooklyn, is seen from the following record of average seats per car which is obtained by dividing the seat miles by the car miles:

	Average Seats per Car
New York	38.7
Brooklyn	45.0
Philadelphia	34.1

Seats per Passenger

Another interesting feature of service operated is the number of seat miles operated per passenger ride, this being the seat miles divided by the number of passengers of all classes, as follows:

	Seat Miles Operated per Passenger Ride
New York	4.5
Brooklyn	5.6
Philadelphia	5.7

From passenger counts made by this firm in these cities it has been found that the average length of ride per passenger is considerably less than these figures, so that all three systems provide on an average considerably more than a seat for every passenger. In the case of the Philadelphia system, by count of passenger miles operated on the entire system, it was found that the average ride per passenger (all classes) on the surface system is about 2.3 miles. This is less than one-half of the seat miles per passenger ride, or in other words, there are operated in Philadelphia an average of about two and one-half times as many seats as passengers. This ratio of seats per passenger is larger in Philadelphia than in New York or Brooklyn.

Passengers

A comparative statement of the annual number of passengers carried on these surface systems is as follows:

	Revenue Passengers	Transfer Passengers	Total Passengers	Transfer Passengers Per Cent of Revenue Passengers
New York	430,679,014	160,538,591	591,217,605	37.3%
Brooklyn	298,701,624	149,009,737	447,711,361	49.9
Boston	236,373,190	115,080,235	351,453,425	41.0
Chicago	429,095,877	310,907,040	740,002,917	72.5
Philadelphia	338,525,650	60,501,687	399,027,337	17.9

The Philadelphia revenue passengers here include 3¢ exchanges, and the transfer and total passengers for Philadelphia and Chicago include complimentary and employes' tickets, while the total passengers

for New York, Brooklyn, and Boston, exclude such tickets. It will be noted that in Chicago and New York there are practically the same numbers of revenue passengers, Philadelphia having considerably less and Brooklyn and Boston less than Philadelphia. On the other hand, due to the large number of free transfers issued in Chicago, the total number of passengers in that city is considerably larger than in any of the others and nearly twice as large as in Philadelphia.

Philadelphia has the smallest number and percentage of free transfer passengers, the proportion of transfer to revenue passengers in New York, Brooklyn and Boston being more than twice as large and in Chicago approximately four times as large. If the 3¢ exchange passengers are counted as transfer passengers, then they and the free transfer passengers in Philadelphia equal 34.8% of the remaining revenue passengers, or a ratio approaching those of New York and Boston. The number of these 3¢ exchange passengers for 1910 was 42,467,617, which at 3¢ paid the Company $1,274,029. This is equivalent to 1.24¢ for each passenger changing cars, counting the exchange and transfer passengers together. Of course, the exaction of a payment for the present free transfers or a reduction in the exchange ticket cost would decrease or increase the number of passengers respectively, and so might change the net average rate.

Passengers per Service Unit

The total passengers carried per car mile and per car round trip were as follows:

PASSENGERS CARRIED (ALL CLASSES)

	Per Car Mile	Per Round Trip
New York	8.6	......
Brooklyn	8.1	71
Boston	8.1	75
Chicago	9.1	......
Philadelphia	6.0	75

It will be noted that the systems in other cities carry from a third to a half more passengers per car mile than in Philadelphia. While this is somewhat accounted for by the smaller sizes of Philadelphia cars, it also confirms the deduction that the Philadelphia system is giving more car mileage service than is operated in the other cities. The fact that Brooklyn and Boston show approximately the same number of passengers per round trip as Philadelphia also tends to prove this statement, as with the length of trip nearly 50% greater in Philadelphia, each trip means approximately that many more car miles.

The total passengers per mile of track are as follows:

	Passengers (All Classes) per Mile of Track
New York	1,195,000
Brooklyn	874,000
Boston	857,000
Chicago	1,292,000
Philadelphia	732,000

The average traffic carried over the Philadelphia tracks is less than in Brooklyn and Boston, and much smaller than in New York and Chicago.

The total passengers of all classes per capita or the rides per annum, and the revenue passengers including 3¢ exchanges per capita, or the fares per annum, compare as follows:

	Rides per Annum per Capita	Fares per Annum per Capita
New York	214	156
Brooklyn	274	183
Boston	337	227
Chicago	339	196
Philadelphia	249	211

It will be noted that the riding public of Boston and Philadelphia furnishes the largest number of fare passengers per capita per annum, this being due to the fact that in the other three cities a large proportion of the traffic is carried on the subway and elevated systems or makes a larger use of transfers. It is believed that a considerable increase in the Philadelphia surface traffic can be produced by improvements both in design of car equipment and in methods of operation which will make the service more attractive. The total rides per annum are lower in Philadelphia than on any of the other systems except that of New York, being occasioned principally by the small amount of transferring in Philadelphia.

Conclusions as to Service

Summarizing the above comparisons of service it is shown that Philadelphia is well in the lead of these surface-car systems as to trackage facilities, car mileage operated, average seats per passenger and length of trip without transfer. It will be possible to reduce slightly the track mileage by improved routing and track rearrangement, providing better average facilities and covering more territory than at present, and also to make some reduction in car mileage during the non-rush hours without detriment to the service.

On the other hand, the maximum number of cars operated at the busiest part of the rush hours (as shown by average maximum cars operated) is less in proportion than in the other cities, this accounting for the abnormal crowding of cars at that period. In Philadelphia the maximum number of cars operated at the rush hours is approximately 39% to 45% greater than on the base schedule during the middle of the day. In some of the other cities twice as many cars are operated at the rush hours as during the middle of the day. The necessity for and the limitations of rush hour service are discussed elsewhere in this report.

Power

A comparison of the approximate power capacity and output of these surface systems is as follows:

	Total Rated Capacity (kilowatts)	Total Output (kilowatt hours)
New York	62,500	200,170,854
Chicago	73,709	284,556,345
Philadelphia	66,775	180,582,513

These figures indicate that for the service operated, the Philadelphia system has power capacity in excess of the other two, which, however, rent a large proportion of their power; while due somewhat to smaller, lighter cars, the amount of power used as shown by the

output is somewhat less than in New York and much less than the amount required by the large, heavy car equipment of Chicago. This is also shown in the number of kilowatt hours distributed per car mile, which is as follows:

	Kilowatt Hours Distributed per Car Mile
New York	2.90
Chicago	3.49
Philadelphia	2.71

The station (load) factors of these various systems are as follows, the Brooklyn and Boston figures including the power used on the elevated systems:

	Station Load Factor
New York	37%
Brooklyn	35
Boston	39
Chicago	44
Philadelphia	37

While these figures are approximate they would indicate that the Philadelphia car system was operated at approximately the average load factor of other cities exclusive of Chicago, where the station factor is considerably better.

From the standpoint of maximum service during the rush hours, a high load factor of the power system would indicate small proportional load at the rush hours, or a small proportion of rush-hour car service with reference to average car service. In other words, street car systems having the highest load factor of power system are those giving the least proportionate service at rush hours.

Total Gross Earnings

The total gross earnings of the surface systems, including for Boston the elevated system, are as follows:

	Total Gross Earnings
New York	$22,955,070
Brooklyn	15,126,714
Boston (Including Elevated)	14,493,853
Chicago	21,951,705
Philadelphia	17,045,577

It will be noted that the earnings of Chicago are almost as great as New York, and that Philadelphia, practically an average of the five, is third, followed by Brooklyn and Boston. In addition to the passenger receipts, the other receipts, such as come from advertising and in some cases from carriage of freight and express matter, average from 3% to 4% of the passenger receipts, except in the case of New York, where additional profit comes from the sale of power. These gross earnings, measured in terms of the various units of traffic and service, are as follows:

Gross Earnings per Unit

	Gross Earnings	
	Per Passenger (All Classes)	Per Car Mile
New York	3.88¢	33.3¢
Brooklyn	3.38	27.3
Boston (Including Elevated)	3.66	28.4
Chicago	2.97	26.9
Philadelphia	4.27	25.6

Due to the small number of free transfers and 3¢ exchanges, the earnings per passenger are largest on the Philadelphia system and smallest in Chicago, where they are 30% less. On the other hand, due to small cars and the large car mileage operated, the gross earnings per car mile are smallest in Philadelphia.

Referred to track mileage and population served, the gross earnings compare as follows:

GROSS EARNINGS

	Per Mile of Track	Per Capita
New York	$46,400	$8.31
Brooklyn	29,500	9.26
Boston (Including Elevated)	33,700	13.88
Chicago	38,300	10.05
Philadelphia	31,200	10.63

The gross earnings per mile of track in Philadelphia, due somewhat to the large track mileage, are least of all excepting those of Brooklyn. Although a large part of its traffic is diverted to the subway and elevated lines, New York shows the highest gross earnings per mile of track, with Chicago next. Philadelphia is highest in gross earnings per capita outside of Boston, which figure includes the subway-elevated earnings. This is due not only to the higher rate of fare, but also to the fact that in the other three cities a large part of the total payments by the public for transportation are diverted to the subway and elevated lines. It is believed that with improved equipment and better public sentiment developed by popular methods, this figure can be increased.

Passenger Receipts

In order to measure the traffic by units of service, especially in connection with the receipts and operation of individual lines, the passenger receipts are considered by themselves, the receipts usually earned by the system as a whole from sources other than passenger traffic being eliminated. The passenger receipts per passenger are as follows:

PASSENGER RECEIPTS

	Per Revenue Passenger	Per Passenger All Classes
New York	4.98¢	3.63¢
Brooklyn	4.87	3.25
Boston (Including Elevated)	4.99	3.54
Chicago	4.96	2.88
Philadelphia	4.88	4.14

As all of these roads charge a flat 5¢ fare, the slight difference between this rate and the average is caused either by a reduced exchange ticket fare as for Philadelphia, by reduced rates for children or by a small amount of reduced rate tickets for postal employes, etc. It is interesting to note that the passenger receipts per passenger of all classes, including the free transfers, and in the last two systems the free passes, are highest in Philadelphia, being over ½¢ higher than New York, which comes second, and 1¼¢ higher than Chicago, which is the lowest. This is a strong point in favor of the intrinsic value of the Philadelphia system and its ability to furnish good public service. It is believed that the public is interested primarily in securing first class service as exemplified by character of car equipment,

amount of trackage, frequency of car headway, reliability and regularity of schedule and amount of rush-hour car capacity; and the Company's power to furnish these, to pay competent wages to its employes and to extend its system to take care of or even to anticipate and accelerate the growth of the city, is generally dependent on the fraction of a cent per passenger. Good financial credit is as essential to the street railway company as good public opinion and this should be recognized by the public in permitting this class of corporation to earn a profit commensurate with that of other classes of business.

Receipts per Passenger Mile

Dividing the passenger receipts by the average length of ride per revenue passenger as ascertained by count, shows that the average passenger receipts per passenger mile on the surface system in Philadelphia are approximately 1.75¢. From the count of passenger mileage made by this firm in some of the other cities in this list and in similar cities, it is believed that these receipts per passenger mile in Philadelphia are higher than in any of the other cities named, in some of which the receipts per passenger mile are believed to be as low as 1.25¢, and they compare favorably with those of other large street railway systems in this country.

Receipts per Operating Unit

The passenger receipts per unit of service are as follows:

Passenger Receipts

	Per Car Mile	Per Seat Mile
New York	31.1¢	.80¢
Brooklyn	26.2	.58
Boston (Including Elevated)	27.4	......
Chicago	26.2	......
Philadelphia	24.8	.73

It will be noted again that the passenger receipts per car mile are lowest in Philadelphia and highest in New York for the reasons stated, while the receipts per seat mile are considerably higher in Philadelphia than in Brooklyn, although not so high in New York, where, however, the surface lines have a large short-haul traffic, due to operation through a number of delivery districts, or traffic centers, which on many lines give a car several loads per trip.

Operating Expenses

While the financial operation of the Philadelphia system is outside of the province of this report, some general comparative statistics of operating expenses have been included, to serve as a side light on the ability of the Company to render service and on the comparative efficiency of its operations.

The total operating expenses of these systems are as follows:

	Total Operating Expenses
New York	$15,713,193
Brooklyn	9,795,222
Boston (Including Elevated)	9,427,181
Chicago	14,098,314
Philadelphia	9,360,458

It will be noted that the absolute amount of the reported operating expenses of the Philadelphia system is less than even those of Boston or Brooklyn, and much lower than those of New York or Chicago.

Operating Expenses per Unit

The operating expenses per unit of business or service are as follows:

OPERATING EXPENSES

	Per Cent of Gross Earnings	Per Revenue Passenger	Per Car Mile
New York	68.4%	3.65¢	22.8¢
Brooklyn	64.8	3.28	17.7
Boston (Including Elevated)	65.1	3.35	18.4
Chicago	64.1	3.29	17.3
Philadelphia	54.9	2.76	14.0

From this will be noted that the reported operating expenses, exclusive of taxes, of the Philadelphia system, are lower than those of any of the other systems by almost 10% of the gross earnings. This ratio of operating expenses is largest in New York and in the other three cities averages about 65%. The large difference in favor of the cost of operating the business of the Philadelphia system is accounted for by the large average receipts per passenger and per passenger mile, the comparative cheapness of cost of power and car operation and the small amount spent and charged to operating expenses for maintenance and renewals of physical property. It is interesting to note from the above figures of operating expenses per revenue passenger just how much of the nickel received, is paid out before anything can be applied to taxes, reserves and return on the investment; such proportion of the nickel being about two-thirds for operating expenses, leaving one-third for these important fixed charge elements of cost of providing the service and for profit.

In operating expenses per car mile, the Philadelphia system is again lowest, due partly to the same causes which reduce its operating ratio, and partly to the smaller and lighter cars.

Maintenance of Way and Structures

The separation of operating expenses into a few general classes follows:

MAINTENANCE OF WAY AND STRUCTURES

	Per Mile of Track	Per Car Mile	Per Cent of Gross Earnings
New York	$5,870	4.21¢	12.7%
Brooklyn	2,507	2.32	8.5
Boston (Including Elevated)	2,445	2.30	10.1
Chicago	2,694	1.89	7.0
Philadelphia	1,695	1.39	5.4

It is noted that this maintenance of the Philadelphia system averages about $1,700 per mile of track as compared with that of the three other overhead trolley systems, which averages about $2,500 per mile of track. The New York system consists largely of the expensive underground trolley construction, a considerable amount having been under reconstruction during this period. In Chicago it is understood that a large portion of track reconstruction has been charged to capital

which would interfere somewhat with the value of the Chicago figures in comparison. The expense of maintenance of way and structures for Brooklyn and Boston is believed to be more nearly normal, and in these two systems averages about 2.3¢ per car mile, or about 9% of the gross earnings, as compared with 1.39¢ per car mile and 5.4% of gross earnings in Philadelphia. On the other hand, as stated, the Philadelphia track construction is of a heavier, more substantial character than the average of these other cities, which should result in lower cost of maintenance.

Maintenance of Equipment

The operating expenses under the heading "Maintenance of Equipment" include maintenance of rolling stock and power plant equipment, except in Brooklyn and Chicago where power plant maintenance is excluded for the portion of power rented, and also in Boston where power plant maintenance is included under cost of power. These expenses are as follows:

MAINTENANCE OF EQUIPMENT

	Per Average Maximum Car	Per Car Mile	Per Cent of Gross Earnings
New York	$706	2.52¢	7.6%
Brooklyn	874	2.69	9.9
Boston	525	1.93	7.1
Chicago	....	1.48	5.5
Philadelphia	524	1.40	5.5

It will be noted that the Philadelphia system almost equals that of Chicago in cost of maintenance of equipment, but is somewhat lower than Boston and considerably lower than New York and Brooklyn (the highest), when this item is measured by all three of these units of service and business. The Chicago figure is probably abnormally low, due to the newness of most of its equipment, and the Philadelphia expenditures are not believed to be sufficient as set forth more fully elsewhere in this report.

Total Maintenance

The total maintenance per unit of service and business is as follows:

TOTAL MAINTENANCE

	Per Car Mile	Per Cent of Gross Earnings
New York	6.73¢	20.2%
Brooklyn	5.01	18.4
Boston (Including Elevated)	4.23	17.2
Chicago	3.37	12.5
Philadelphia	2.79	10.9

The above qualifications as to abnormal nature of maintenance in New York and Chicago apply to these figures, as compared with what is believed to be an average expenditure for maintenance in Brooklyn and Boston. A return into the property from income of from 4 to 5 cents per car mile or from 17 to 18% of the gross earnings represents an average of a large number of American systems and compares with 2.79¢ per car mile, and 10.9% of the gross earnings expended by the Philadelphia system. It is believed that this Company should provide about 7% more of its gross earnings for maintenance and renewals.

Cost of Power

The cost of power, exclusive of maintenance and including in the New York, Brooklyn, Boston and Chicago systems the cost in the charge for rented power of the operating expenses, fixed charges and profit paid for this outside service, is as follows:

COST OF POWER

	Per Kilowatt Hour Distributed	Per Car Mile	Per Cent of Gross Earnings
New York	1.22¢	3.55¢	10.6%
Brooklyn	.43	2.58	9.4
Boston (Including Elevated)	.74	2.39	8.5
Chicago	.83	2.89	10.7
Philadelphia	.65	1.43	6.8

The cost of power in Philadelphia per electrical unit of the kilowatt hour compares favorably with the other cities. The cost of power per car mile in Philadelphia is very much less than in any of the other cities, this being due not only to the low cost of production, but to the light weight of car equipment. The Philadelphia system shows also a smaller percentage of gross earnings expended for power than the other systems, which can be considered as direct evidence of greater operating efficiency in this particular.

Platform Wages

A comparison of the platform wages in terms of service and traffic is as follows:

PLATFORM WAGES

	Per Car Hour	Per Car Mile	Per Cent of Gross Earnings
New York	46.7¢	6.28¢	18.9%
Brooklyn	41.6	5.20	19.1
Boston (Including Elevated)	63.2	6.47	26.8
Chicago	....	6.80	25.2
Philadelphia	46.0	5.77	22.6

The cost of platform wages, or payments to motormen and conductors, is higher per car hour in Philadelphia than in Brooklyn, and almost equal to the rate in New York, although considerably less than in Boston, which figure includes wages of all car service employes. The Philadelphia system spends about the average amount of the five cities for this item, as figured in percentage of gross earnings.

Total Operation of Cars

The total cost of "operation of cars" comprising platform wages and other transportation expenses, exclusive of maintenance and power, is as follows:

TOTAL OPERATION OF CARS

	Per Car Hour	Per Car Mile	Per Cent of Gross Earnings
New York	63.2¢	8.50¢	25.6%
Brooklyn	59.2	7.39	27.1
Boston (Including Elevated)	83.4	8.22	29.0
Chicago	....	7.88	29.2
Philadelphia	53.5	6.72	26.3

From the standpoint of economy of operation of cars, as shown by these figures, the Philadelphia system makes the best showing.

Damages and Legal Expenses

A detailed comparison of accident statistics is given in another portion of this report. The cost of damages and legal expenses of these systems, however, is as follows:

DAMAGES AND LEGAL EXPENSES

	Per Cent of Gross Earnings	Per 1,000 Passengers (All Classes)	Per Car Mile
New York	7.3%	$2.85	2.44¢
Brooklyn	5.9	1.98	1.60
Boston (Including Elevated)	5.8	2.13	1.66
Chicago	7.4	2.21	2.00
Philadelphia	6.7	2.88	1.72

It will be noted that the cost of this item of expense for the Philadelphia system is about the average in percentage of gross earnings, but is higher than any of the other systems in terms of 1,000 passengers. The latter is due, however, to there being fewer total passengers in Philadelphia on account of the small number of transfer passengers. The cost of damages and legal expenses per car mile is also somewhat less than the average of the other systems, due partly to the fact of the large number of car miles operated in Philadelphia. In general it may be said that the cost of damages and legal expenses in Philadelphia is not above the average of these systems.

Other General Expenses

The other general expenses, including salaries of officers and clerks, office and other expenses of a general nature are as follows:

OTHER GENERAL EXPENSES

	Per Cent of Gross Earnings	Per Car Mile
New York	4.7%	1.56¢
Brooklyn	4.0	1.09
Boston (Including Elevated)	4.6	1.29
Chicago	4.3	1.16
Philadelphia	4.2	1.06

It will be noted that the Philadelphia expenditures are about equal to those of Brooklyn and Chicago, and slightly less than those of New York and Boston.

Total General Expenses

The summary of damages, legal expenses and other general expenses is as follows:

TOTAL GENERAL EXPENSES

	Per Cent of Gross Earnings	Per 1,000 Passengers (All Classes)	Per Car Mile
New York	12.0%	$4.67	4.00¢
Brooklyn	9.9	3.33	2.69
Boston (Including Elevated)	10.4	3.80	2.95
Chicago	11.7	3.48	3.16
Philadelphia	10.9	4.65	2.78

These figures, with the above qualifications, show that the Philadelphia system is near the average of all of these systems in its general expenses.

CAR MAINTENANCE

The public is interested in the proper maintenance of cars and in their exterior and interior appearance from the standpoints of safety, reliability of service, comfort and health. From the standpoint not only of economical operation, but also of providing a popular public service, the street railway company should be alive to the necessity of keeping up an even standard of efficient inspection and maintenance.

Comparative Maintenance Conditions of Philadelphia Surface Cars

Statistics were obtained from the Company for the fiscal years 1907, 1908, 1909 and 1910, as to the number and causes of "pull-ins," number of car maintenance employes, amount of car painting, renewal of parts and cost of car maintenance, together with data regarding car cleaning. This information has been measured by units of schedule car days and car miles operated, and included in the tabulated statements of Volume II. The schedule car days operated for one year are a summation of maximum cars operated at any one time for each day of the year. This unit forms a basis of judging maximum service, as the amount of car maintenance varies to an extent with the total number of cars owned and operated.

Number of Pull-ins

A "pull-in" is defined as the removal of an operating car from service by sending it to the car barn or shop, when necessary by reason of failure of equipment or accident. All of the following statistics exclude the extraordinary maintenance due to strike conditions occurring in the years 1909 and 1910:

TOTAL PULL-INS

	Number	Schedule Car Days per Pull-in	Car Miles Operated per Pull-in
1907	5,874	112	13,741
1908	3,805	169	20,847
1909	2,293	247	30,496
1910	2,713	209	24,580

The comparative number of pull-ins is an indication of the physical condition of the cars, showing whether the cars are properly inspected and maintained. Pull-ins are also caused by collisions due often to poor discipline, and by derailments which may be due to poorly maintained track or pavement.

Of the above pull-ins, those caused by failure of equipment were as follows:

PULL-INS CAUSED BY FAILURE OF EQUIPMENT

	Number	Schedule Car Days per Pull in	Car Miles Operated per Pull in
1907	2,736	241	29,502
1908	1,733	370	45,773
1909	1,186	478	58,960
1910	1,325	428	50,329

It will be noted that there was considerable improvement from 1907 to 1909, as the number of pull-ins per unit of operation was cut practically in half during that time. The year 1910 shows conditions almost equal to 1909, the slight difference possibly being caused by temporary extraordinary conditions. The percentage of defects of electrical equipment to total car defects has slightly increased during the three years, the percentage of defects of bodies and trucks decreasing slightly during the same period.

As compared with other large street railway systems, the number of pull-ins is much smaller in Philadelphia, both in total and per unit of service. While it is the rule in Philadelphia that cars are kept out in operation as long as practicable and that with some other companies cars are taken off the street for slight defects, yet the number of pull-ins in Philadelphia is so disproportionately small as to cause these comparisons with other systems to be of little value.

Car Maintenance Employes

The comparative amount of maintenance work can be judged also by the number of car maintenance employes, number of parts renewed and the cost of maintenance.

The number of car maintenance employes was as follows:

CAR INSPECTION AND REPAIR MEN

	Number	Schedule Car Days per Man	Car Miles per Man
1907	889	743	90,795
1908	813	788	97,569
1909	824	688	84,862
1910	884	642	75,436

The number of maintenance employes has remained about the same during this period while the car miles operated have decreased about 17%. In proportion to service, therefore, the car maintenance force has increased about 15%. The present car maintenance force is about as large as that employed on other systems of this size.

Parts Renewed

For the same period the number of pairs of wheels changed has decreased from 13,547 in 1907, to 8,120 in 1910. The number of gears renewed decreased from 724 in 1907 to 277 in 1909, increasing again to 807 in 1910. The number of pinions renewed decreased from 4,187 in 1907 to 2,901 in 1910, while the number of armatures removed increased from 7,006 in 1907 to 10,860 in 1910, and the number of fields removed increased from 1,321 in 1907 to 5,263 in 1909, decreasing to 4,319 in 1910. This would indicate that the amount of electrical repairs has considerably increased in this period both in total and per unit of service. This increase is principally due to the small amount of electrical maintenance in the earlier years of this period when the old motors had recently been replaced with modern motors. The amount of electrical maintenance compared with other large street railway properties indicates more repairs of this character in the Philadelphia property than elsewhere, while the wheel renewals are about the average in other places.

Fender Maintenance

The maintenance of fenders is poorly attended to. Due to its projection and use in narrow streets the type of fender used in Philadelphia requires frequent inspection and repairs. On a total of 1,188 cars observed while in operation on the street during July and August, 1910, 17% of the fenders were in good condition, 58% in fair condition, and 25% in bad condition.

Cost of Car Maintenance

The cost of maintenance of car bodies, trucks and motors, was as follows:

COST OF CAR MAINTENANCE

	Amount	Per Scheduled Car Day	Per Car Mile
1907	$863,568	$1.31	1.07¢
1908	783,494	1.22	0.98
1909	796,277	1.40	1.14
1910	864,680	1.52	1.30

Consequently the cost of car maintenance has increased per unit of service about 20%, but even this is not large enough to provide for current maintenance which, it is believed, should average for the present cars about 1.50¢ per car mile exclusive of car renewals or depreciation.

Car Painting

With regard to car painting and varnishing, the statistics are as follows:

CAR PAINTING

	Cars Completely Painted	Cars Partially Painted and Varnished	Total Cars Painted
1907	455	786	1,241
1908	448	535	983
1909	473	755	1,228
1910	568	1,359	1,927

When compared with the total number of surface cars owned, namely, 3,292, it will be seen that the Company's schedule of car painting is much less than it should be, and this is confirmed by the condition of the cars.

During July and August, 1910, out of 1,188 cars observed in operation, 20% were painted red, which was the color of the old People's and Hestonville systems, indicating that these cars had not been painted for 10 or 12 years.

Of the cars observed as to painting, 12% were in good condition, 33% in fair and 55% in bad condition.

The usual schedule of surface car painting requires partial painting and varnishing of each car once every 12 to 18 months, and complete painting once every 5 to 8 years, depending on character of partial painting and maintenance. The Philadelphia company has apparently no definite schedule of painting and varnishing cars, the statement being made that cars are painted as often as necessary.

At an average of one partial painting and varnishing every 15 months the present 3,292 cars should go through the paint shop at the rate of about 9 cars per working day. During the past 4 years 5,379 cars have gone through the paint shop or an average of 4.5 cars

per working day. The average amount of painting for this period has therefore been just about half as much as usual practice and careful maintenance would dictate. This condition improved somewhat in 1910, however, as 1,927 cars were put through the paint shop or an average of 6.4 cars per working day.

The surface-car paint shop has room for 44 double-truck or 55 single-truck cars. At the rate of once every 15 months for partial painting and once every six years for complete painting, the present surface car equipment would require about twice as much paint shop space as at present. The subway-elevated shop has sufficient paint shop facilities, but the painting of these cars has not been well kept up due to insufficient reserve or extra equipment. A definite schedule of car painting and varnishing should be adopted, not only to give the cars a presentable appearance on the street, but also to preserve them and ultimately to reduce the average cost of car painting.

Car Cleaning

The car cleaners are practically all located at the barns, the number of cleaners and cost having been as follows:

CAR CLEANING

	Average Number of Cleaners	Cost of Cleaning	Cost per 1,000 Car Miles
1907	212	$133,548	$1.65
1908	164	107,069	1.35
1909	145	97,831	1.40
1910	175	103,918	1.56

This number of car cleaners and cost of cleaning should be sufficient to keep the cars in good condition as it is larger in proportion to service operated than on other large systems on which the cars are well cleaned.

From inspection, the cleaning of car interior and windows appears well done but the washing of exterior is often neglected.

Method of Car Inspection and Repairs

The Company's car maintenance is under the direction of two branches of its organization. The transportation organization looks after the small repairs made at the operating barns. The maintenance organization attends to general overhauling and reconstruction at the two main shops. In the transportation organization, under the General Manager and General Superintendent are the division or depot superintendents. Each of these is located at an operating barn, having directly under him the inspectors, dispatchers and car operatives. At the larger barns there are also assistant superintendents. The division superintendent also has direct charge of the barn repairmen under the barn foremen, night and day. These barn foremen have charge of the small repairs which are effected by repairmen, who also act as car inspectors, pitmen, car greasers, etc. This repair work, comprising replacement of wheels, brake shoes, armatures and fields, air equipment, small woodwork, etc., is done at all of the 19 operating barns except the Hancock and 10th and 11th Streets barns, which have insufficient facilities.

Under charge of the maintenance organization the larger repairs, such as painting and overhauling of car body, armature and field winding, etc., are done at the Kensington Ave. Central Shops. The 8th

and Dauphin Shop attends to the wheel work and wagon repairs, together with the rebuilding of old cars into new types.

The distinctively car maintenance organization, according to the plan put in force in January, 1906, is in the charge of the Superintendent of Rolling Stock and Equipment, who reports to the General Manager. Next to him in correlative positions are the Master Mechanic in charge of the 8th and Dauphin Shop, the Shop Superintendent in charge of the Kensington Ave. Central Shop, and the Chief Mechanical Inspector. The latter has a force of six mechanical inspectors, of whom four are in charge of four mechanical inspection divisions into which the system is divided, and two are used on special duty which includes the checking of the four division inspectors. These inspectors decide upon and check the barn foremen's work and lay out with them the schedule of barn repair work. Their principal duty, however, is to inspect operating cars and to report defects to the Chief Mechanical Inspector and barn foreman. They also look up defective equipment for the Claim Department and make statistical monthly reports on special subjects. Questions of authority as between the work of the barn foremen and mechanical inspectors go up to the General Manager for settlement.

The above organization is for surface cars only. For the subway-elevated system the organization consists, under the General Manager, of the Superintendent of Elevated Division, and under him the shop foreman of the elevated shop with his own inspectors and repairmen.

Regular Inspection of Surface Cars

Surface cars are inspected as follows:

1. Car troubles reported daily to barn foremen by car operatives on "O. K. cards." Apparently these are not always turned in.
2. Barn inspection.
    (a.) Daily inspection by barn repairmen, covering body, brakes, trolleys, air equipment, etc. The controllers and motors are covered by the same inspection about once every two days.
    (b.) Complete barn overhauling and inspection by the same men, which averages once every 60 days.
3. Inspection of all operating car equipment, made at the barn by the six mechanical inspectors, this averaging once per month. Duplicate inspection reports are sent both to the barn foremen and to the Superintendent of Rolling Stock and Equipment. These are not in complete or statistical form and are not compiled.

Neither inspection nor overhauling is made on a mileage basis. The daily mileage per car averages about 100 miles and the complete barn inspection and overhauling about once every 6,000 miles. A systematic inspection based on mileage operated should be made for every 600 to 800 miles, this being the method usually adopted by large street railways.

Reports

Apparently no complete report is made by the Superintendent of Rolling Stock and Equipment to the General Manager. From the records of the Company it would appear that while the general

periodical reports of the claim, track and overhead line departments are made in considerable detail and contain a great amount of valuable data, this is not the case with the car maintenance and transportation departments. It is desirable that such reports be made not only for the benefit of the heads of these departments, but also when summarized, for the prompt information of the General Manager as to these two important departments.

Conclusions

It is believed that the good general character of the car maintenance of the Philadelphia company is largely due to the ability of the officials in charge of the various parts of this work. The maintenance expenditures on both surface and subway-elevated lines seem to be well made, although not of sufficient amount, the car painting as stated being especially deficient.

ACCIDENTS

In order to determine with some accuracy whether the operation of the surface and the subway-elevated cars in Philadelphia is productive of more than the average number of accidents attending this class of business, it is necessary to reduce these occurrences to the basis of statistics in terms of traffic and service, not only by years for a period past for the Philadelphia system, but also to compare these figures for the latest year with the systems of other large cities. In the comparison of these records, the differences in traffic, car equipment, methods of operation, density of vehicle and pedestrian travel and characteristics of population must be allowed for, rendering these statistics of value merely as general indications.

Fortunately, the statistics of New York and Brooklyn were available from the comprehensive records of the Public Service Commission, and others not so complete were obtained for Boston from the records of the Massachusetts Railroad Commission. For Chicago nothing on this subject was available.

Due to human fallibility and to physical limitations of material and mechanism, a certain liability of accident is present in any form of motion. Such accidents may be termed unavoidable. Other accidents of a greater or less proportion depending on efficiency may be classed as preventable. The amount of these depends most largely on the discipline of the operating force and on the design and maintenance of the physical property.

It is believed that this is one of the most important fields for governmental regulation. In connection with requirements relating to the design and maintenance of the car equipment, the work of the Public Service Commission of New York has effected a substantial reduction of accidents on the surface lines.

Number of Accidents

The number of accidents by years and classes as reported by the Company occurring on the surface system and also on the subway-elevated system is shown in the tabulated statements of Volume II for the years 1907 to 1910, inclusive. On the Philadelphia system all reported occurrences involving possible liability for damages are considered as accidents. The number of these accidents, however, cannot be compared accurately with those of other cities, as the definition of "accident" varies. On the surface system the total number of accidents reported, exclusive of extraordinary accidents due to strike conditions, is as follows:

Fiscal Year	Total Accidents
1907	36,981
1908	32,119
1909	31,374
1910	34,078

Fatal Accidents (Surface)

The record of fatal accidents, being the total passengers, employes and others killed, is as follows:

	Fatal Accidents
1907	113
1908	98
1909	55
1910	70

It will be noted that a considerable reduction has been made in these fatal accidents, the number of passengers killed having been reduced in this period from 42 to 7, and the number of employes killed from 10 to 3. The number of "others" killed has averaged 60 per year, these being principally pedestrians struck. Based on the experience of New York City, it is believed that this latter class of accident can be reduced by the use of automatic wheel guards, and this is strongly recommended. It should be noted that the number of car miles operated per passenger killed has increased during this period from 714,310 car miles to 952,646.

The number of passengers carried (all classes) per person killed, was as follows:

	Passengers Carried per Person Killed
1907	4,318,976
1908	5,090,537
1909	7,961,269
1910	5,700,390

In a comparison of these accident statistics for 1910 with those of surface systems of New York, Brooklyn and Boston, there is shown the following:

	Car Miles Operated per Person Killed
New York	801,869
Brooklyn	924,258
Boston	1,381,830
Philadelphia	952,646

It will be seen that excepting Boston, the Philadelphia record for 1910 is best. It is slightly ahead of Brooklyn and considerably better than New York, although in the latter case, due to the denser traffic, there is greater hazard.

The number of passengers carried (all classes) per person killed for the fiscal year 1910, was as follows:

	Passengers Carried per Person Killed
New York	6,874,623
Brooklyn	7,461,856
Boston	10,705,100
Philadelphia	5,700,390

On this basis the Philadelphia system does not appear to make as good a showing as the other systems, but as only 10 per cent. of the persons killed in Philadelphia were passengers compared with 25 per cent. in Brooklyn, 14 per cent. in New York and 27 per cent. in Boston, the number of passengers carried per passenger killed is of

more value, in which case the figures would be approximately as follows:

	Passengers Carried per Passenger Killed
New York	49,000,000
Brooklyn	29,000,000
Boston	35,000,000
Philadelphia	57,000,000

It will thus be seen that from the standpoint of passengers, the Philadelphia system is the safest of the three, although more hazardous to pedestrians.

Personal Injuries (Surface)

Similarly, for the Philadelphia system the total number of persons injured was as follows:

	Total Persons Injured
1907	19,343
1908	11,598
1909	6,694
1910	7,240

A large reduction in personal injuries has taken place during this period. This is more readily judged by a comparison of the number of car miles operated per person injured, which is as follows:

	Car Miles per Person Injured
1907	4,173
1908	6,838
1909	10,446
1910	9,210

The number of passengers carried (all classes) per person injured is of some interest in this connection, and is as follows:

	Passengers Carried per Person Killed
1907	25,231
1908	43,014
1909	65,412
1910	55,084

It will thus be noted that a very considerable improvement has been made in this particular. Of the total persons injured about half are passengers and the other half principally pedestrians struck.

In comparison with the surface car systems of other cities the number of persons injured for the fiscal year 1910, was as follows:

	Total Persons Injured
New York	14,643
Brooklyn	8,653
Boston	3,112
Philadelphia	7,240

As the Boston system is smaller than the others and has a larger proportion in outlying suburban districts, the accident hazard is less.

The number of car miles operated per person injured, is as follows:

	Car Miles per Person Injured
New York	4,709
Brooklyn	6,409
Boston	16,429
Philadelphia	9,210

The number of passengers carried per person injured, was as follows:

	Passengers Carried per Person Injured
New York	40,375
Brooklyn	51,741
Boston	127,278
Philadelphia	55,084

It will be noted that the number of personal injuries occurring in Philadelphia measured by all of these standards is less than those of the surface car systems of Brooklyn and New York.

Accidents Causing Property Damage

The number of accidents causing property damage, exclusive of damages to Company's property, has decreased from 4,314 in 1907 to 2,112 in 1910. While these accidents are not as serious as those causing personal injury, the large reduction is an evidence of improvement in operating conditions.

Claims

The total annual number of claims made for damages on the Philadelphia surface system has decreased from 19,373 in 1907, to 7,665 in 1910. During the same period the ratio of claims disposed of, to claims presented has increased from 64.6 per cent. to 86.1 per cent. These figures denote a considerable improvement in the operation of the Claim Department, which seems to be efficient.

Payments for Injuries and Damages

The statistics of payments for injuries and damages on the Philadelphia surface system also show a considerable improvement from 1907 to 1908, but a gradual increase thereafter, as will be noted from the following:

Payments for Injuries and Damages
(Including legal expenses in connection)

	Amount	Per Car Mile	Per 1,000 Passengers	Per Cent. of Transportation Revenue
1907	$1,780,839	2.21¢	$3.65	9.88%
1908	1,078,407	1.36	2.16	6.00
1909	1,063,643	1.52	2.43	6.19
1910	1,149,261	1.72	2.88	6.95

The amount of money disbursed on account of damages is no indication of the efficiency of operation during the same period, as these payments largely cover accidents which occurred in previous years. The policy of the company's claim department as to payment of claims also may change from year to year.

Comparative figures for other cities are as follows:

PAYMENTS FOR INJURIES AND DAMAGES

	Amount	Per Car Mile	Per 1,000 Passengers	Per Cent. of Transportation Revenue
New York	$1,682,990	2.44¢	$2.85	7.84%
Brooklyn	884,878	1.60	1.98	5.98
Boston	844,277	1.66	2.13	6.00
Philadelphia	1,149,261	1.72	2.88	6.95

From this it will be noted that the 1910 payments in Philadelphia in percentage of transportation revenue, average about the same amount as in these other cities.

Classification of Accidents

The total accidents reported in Philadelphia for the four years under consideration, 1907 to 1910, have been classified in the tabulated statements of Volume II. It should be noted that the "alighting" accidents decreased from 6,237 in 1908, to 4,597 in 1910, and the "boarding" accidents decreased from 3,909 in 1909, to 2,787 in 1910, this showing the value of the platform doors and folding steps of the Pay-Within car.

The annual number of "car collision" accidents has decreased from 4,340 in 1907 to 919 in 1909, with an increase to 2,562 in 1910, although the "vehicles struck" and "persons struck" remain about the same, while the "other accidents," (miscellaneous), have slightly increased. The effect of the Pay-Within car is also shown in the improvement in the number of passengers (all classes) per "alighting" and "boarding" accident reported for 1910 over 1909. The total car miles operated per "car collision" reported shows a considerable improvement for 1910 over 1907, although not over 1909. The car miles operated per "total vehicles and persons struck" shows less favorably for 1910 than for any of the previous years, this being due it is thought, to poor discipline caused by the strike during this period.

Effect of Pay-Within Cars on Accidents

At June 30, 1910, 478 Pay-Within cars were operated on 22 of the Philadelphia lines, out of a total of 562 cars reconstructed at that date, this being about 25 per cent. of the 1,846 cars required for the summer schedule. Pay-Within cars had been used on half of these lines for over a year and had been introduced on most of the others in the early half of that fiscal year. Statistics were secured from the Company to show the comparison between the accidents reported for

these cars and for the old style cars for the year to June 30, 1910, and these statistics are summarized as follows:

COMPARISON OF ACCIDENTS REPORTED FOR PAY-WITHIN AND OTHER CARS OCCURRING DURING YEAR TO JUNE 30, 1910

Class of Accident	For Pay-Within Cars		For Other Surface Cars		Total for Surface Cars	For Subway-Elevated Cars
	Number of Accidents	Ratio to Total Surface Car Accidents of Same Class	Number of Accidents	Ratio to Total Surface Car Accidents of Same Class	Number of Accidents	Number of Accidents
1. Boarding Cars	431	16.0%	2,261	84.0%	2,692	95
2. Leaving Cars	297	6.5	4,244	93.5	4,541	56
3. Station	.....	.....	.....	.....	.....	265
4. Passengers Falling from Cars	15	3.0	485	97.0	500	.....
5. Passengers Falling on Cars	438	36.6	757	63.4	1,195	.....
6. Pedestrians Struck	412	27.6	1,084	72.4	1,496	.....
7. Collisions with Cars	623	24.4	1,939	75.6	2,562	.....
8. Collisions with Cars, Vehicles, &c.	3,384	28.4	8,538	71.6	11,922	.....
9. Miscellaneous	373	16.7	1,852	83.3	2,225	.....
10. Other Reports of Slight Occurrences	2,270	31.8	4,866	68.2	7,136	134
Total	8,243	24.0%	26,026	76.0%	34,269	550

	Pay-Within		Other Surface		Total
	Number	Per Cent. of Total	Number	Per Cent. of Total	Surface
Cars Operated as per Schedule at June 30, 1910	478	25.9%	1,368	74.1%	1,846

The above shows that while between 20 and 25 per cent. of the total surface cars in operation were of the Pay-Within type, the "Boarding," "Leaving" and "Falling from Car" accidents were only 16.0, 6.5 and 3.0 per cent., respectively, of the total accidents of these classes. This would indicate the lessening of hazard by the closing of platform doors when the car is in motion and by the use of folding steps. These classes of accidents and "Pedestrians Struck" are apt to be the most serious of those occurring in surface car operation. The general adoption of the safeguards just mentioned on the one hand and the use of wheel guards, flush draw heads and mechanical sanders on the other, will remove a large proportion which may now be classed as preventable accidents.

The large proportion (36.6 per cent.) of "Passengers Falling on Cars" occurring on Pay-Within cars shows the necessity of additional steadying devices both inside the car and especially on the platforms, such as pipe rails, stanchions and grab handles.

Subway-Elevated Accidents

Comparatively few accidents occur on the Philadelphia subway-elevated line. During its four years of operation 4 employees have been killed and no passengers or others, while the total personal injuries reported for the year 1910 were 425. The total payment for injuries and damages was $1,992, or 0.13 per cent of the transportation revenue.

Comparison of such a small system with the total for subway and elevated lines of New York and Brooklyn is not of much value. In the latter case for 1910 there were 9,910 accidents reported, involving a total of 76 persons killed and 7,227 injured. The amount paid for injuries and damages was $439,587, which amounted to 1.16 per cent. of transportation revenue. 1,971,258 car miles were operated per person killed as compared with 2,129,061 on the Philadelphia subway-elevated line, and for New York and Brooklyn 20,730 car miles were operated per person injured as compared with 10,019 for Philadelphia. 10,019,604 passengers were carried per person killed in New York and Brooklyn and 16,928,458 in Philadelphia, while 105,367 passengers were carried per person injured in New York and Brooklyn, and 79,663 in Philadelphia.

Conclusions

From the above statistics it may be concluded that the effect of the doors and steps of the Pay-Within car has been of distinct benefit, and that in spite of the labor difficulties of the Philadelphia system during the past two years and their attendant handicap to careful, safe operation of cars, and in spite of the narrow streets, the number and nature of accidents and cost of damages of the Philadelphia Rapid Transit Company compare favorably with those of other large systems. With the general installation of wheel guards and mechanical sanders, the proper maintenance of projecting fenders where used, and the modification of draw-bars, it is believed that a still better showing can be made.

TRAFFIC AND SERVICE

Systematic observations of traffic and service were made during the period from July 12, 1910, to February 1, 1911. These observations on all parts of the system comprise:

1. Preliminary car riding observations, from July 12 to September 1, to determine
   a. Characteristics of traffic.
   b. Principal time points.

2. Preliminary rush-hour street observations between 4 and 7 p. m., from July 15 to August 26, to determine
   a. Number of passengers carried past or away from each important point.
   b. Regularity of schedule.
   c. Car loading.

3. General passenger count of entire system, being a 24-hour car riding count of an average of 12% of the cars of each line by selected groups, made on week days except Saturdays, Sundays and holidays, between August 29 and September 22, to record
   a. Passengers on and off at each stop.
   b. Time of car at schedule points.

From these records in connection with counts of transfers and exchanges for the same days there may be determined for each line and for the system the following:

A. Average length of ride per passenger.
B. Number of passenger miles operated.
C. Average rate of fare per passenger mile.
D. Proportion of passengers originating and delivered in each section.
E. Approximate destination and routes of passengers.
F. Points of maximum loading.
G. Load zones.
H. Balancing of traffic on double end lines.

4. Rush-hour street observations at boundaries of delivery district between 4 and 7 p. m. to determine
   a. Number of passengers carried into and out of delivery district.
   b. Regularity of schedule.
   c. Car loading.

This count was made as follows:

A. Daily by selected groups of lines from August 29 to September 22.
B. Simultaneously for all lines on Wednesday, October 5, and Thursday, October 6, (the "cordon" count, supplemented by similar information from steam railroads and ferries).
C. Daily by selected groups of lines for a composite day of the period from Dec. 19 to Dec. 23, inclusive.

5. Street observations of car equipment from July 15 to October 1, to determine

a. Type of cars used on each line.
b. Condition of car maintenance.

6. Street observations between 10 a. m. and 2. p. m., from December 1, 1910, to February 1, 1911, to determine

a. Adequacy of non-rush or base schedules.
b. Regularity of schedule.

General Passenger Count

The general passenger count was conducted by observers placed on one car in every eight of each line for 24 hours to record the number of passengers on and off at each stop. As about 1,800 cars are operated it was not feasible to cover the entire system in one day and therefore the count was made by groups of related or adjacent lines, extending from August 29 to September 22, 1910. No observations were taken on Saturdays, Sundays or holidays.

The records made on the cars are combined, giving the net number of passengers between stops, and these numbers multiplied by distance equal the passenger miles carried. The average length of ride per passenger is obtained by dividing the total passenger miles as above by the number of passengers counted. From this unit calculated for each line, the total passenger mileage for all passengers carried, is obtained.

In order to determine fairly the volume and the characteristics of travel in different sections of the city it is necessary to divide the double-end lines running north and south through the delivery district. The fifteen double-end lines have therefore been treated as if divided at Market Street.

The Delivery District is defined as the area bounded by Cherry, Locust and 17th Streets and the Delaware River.

The Northeast lies east of and includes Front Street.

The North Suburbs are considered to include all the territory north of a line through Hunting Park.

North Philadelphia extends from Cherry Street to Hunting Park, and from Front Street to the Schuylkill River.

South Philadelphia includes all territory south of Locust Street between the rivers.

Darby, Lansdowne and Overbrook are treated as a part of West Philadelphia.

The average length of ride by groups of lines is found to be as follows:

	Average Length of Ride per Passenger (All Classes) (miles)	Cash Receipts per Passenger Mile
Lines from Delivery District to:		
Northeast	2.57	1.61¢
North Philadelphia	2.24	1.95
North Suburbs	3.72	1.09
South Philadelphia	1.86	2.33
West Philadelphia	2.47	1.78
Average Delivery District Lines	2.42	1.72

Crosstown Lines:	Average Length of Ride per Passenger (All Classes) (miles)	Cash Receipts per Passenger Mile
West	1.34	2.20
South	1.42	2.35
North	1.98	1.87
Average Crosstown Lines	1.74	1.98
Suburban Lines	8.72	1.57
Average, Surface System	2.31	1.75
Subway-Elevated	3.27	1.27
Average, Entire System	2.38	1.71¢

The average length of ride as given above, is for passengers of all classes, whether riding on tickets, cash, 3-cent exchanges or free transfers. The average length of ride per revenue passenger (including 3-cent exchanges) was 2.71 miles on the surface system and 3.96 miles on the subway-elevated, or an average of 2.79 miles on the entire system.

Line Statistics Derived from Count

The relation between traffic and service is shown in tabulated statements in Volume II giving statistics compiled for each line on the day of the passenger count, covering car miles, seat miles, passenger miles and ton miles. From these statistics have been derived also for each line:

Passengers per car mile,
Average number of passengers on each car at all times (indicating density of travel),
Average seats per car,
Seats per passenger,
Receipts per seat mile,
Average weight of cars,
Average weight of car and passengers per seat,
Average weight of car and passengers per passenger.

In order to show the relative characteristics of each line, these derivatives are each shown in percentage of average for the entire surface system.

Passengers per Car Mile

The number of passengers (all classes) carried per car mile, varies from 13.4 on the 52d Street Line to 1.7 on the Zoo Line.

By groups of lines the number of passengers per car mile and relation to average for the surface system are as follows:

Lines from Delivery District to:	Passengers per Car Mile	Percentage of Average
Northeast	6.2	102%
North Philadelphia	6.6	108
North Suburbs	4.9	80
South Philadelphia	7.5	123
West Philadelphia	5.4	89
Average Delivery District Lines	6.0	99

Crosstown Lines:	Passengers per Car Mile	Percentage of Average
West	8.0	131
South	6.7	110
North	6.1	100
Average Crosstown Lines	6.6	108
Suburban Lines	4.0	66
Average, Surface System	6.1	100
Subway-Elevated	6.9	113%

Passengers per Car

The average number of passengers on each car at all times, varies from 24.4 on the 10th & 11th Street Line north of Market, to 1.3 on the Zoo Line.

By groups of lines, this derivative is:

Lines from Delivery District to:	Average Passengers on Each Car	Percentage of Average
Northeast	16.1	115%
North Philadelphia	14.6	104
North Suburbs	18.0	129
South Philadelphia	14.0	100
West Philadelphia	13.3	95
Average Delivery District Lines	15.0	107
Crosstown Lines:		
West	10.6	76
South	9.8	70
North	11.6	83
Average Crosstown Lines	11.1	79
Suburban Lines	9.5	68
Average, Surface System	14.0	100
Subway-Elevated	22.6	161%

Seats per Passenger

Excluding less important lines, the seats per passenger (all classes) vary from 5.3 on the Dickinson Line north of Market Street, to 1.5 on the Fox Chase Line south of Market Street.

Receipts per Seat Mile

By groups of lines the seats per passenger and the receipts per seat mile were as follows:

Lines from Delivery District to:	Seats per Passenger	Ratio to Average	Receipts per Seat Mile	Ratio to Average
Northeast	2.6	93%	0.63¢	102%
North Philadelphia	2.7	96	0.72	116
North Suburbs	2.3	82	0.48	77
South Philadelphia	2.7	96	0.85	137
West Philadelphia	3.0	107	0.60	97
Average Delivery District Lines	2.7	93	0.65	105

Crosstown Lines:	Seats per Passenger	Ratio to Average	Receipts per Seat Mile	Ratio to Average
West	3.7	132	0.60	97
South	4.1	146	0.60	97
North	3.5	125	0.54	87
Average Crosstown Lines	3.6	128	0.56	90
Suburban Lines	3.8	135	0.41	66
Average, Surface System	2.8	100	0.62	100
Subway-Elevated	2.1	75%	0.59¢	95%

It is noticeable that the seats per passenger vary inversely as the average length of ride and directly as the number of cars or seating capacity provided. On long lines, therefore, the seats per passenger are less than the average, but if the traffic is light, as on the crosstown and suburban lines, the seats per passenger tend to be greater. On the subway-elevated line the proportion of standing to seated passengers is so great at the rush hour that the seats per passenger are less than the average. The receipts per seat mile are high where the average ride is short and the traffic heavy. On the subway-elevated line the average ride is long and the traffic heavy, producing receipts per seat mile only 5% less than the average for the surface system.

Average Weights Carried

The average weight of empty cars on the surface system was 13.8 tons or 700 pounds per seat, this being equivalent to 1,980 pounds per passenger carried. The average weight of cars and passengers carried on the surface system was 2,120 pounds per passenger, and on the subway-elevated line 3,420 pounds per passenger.

Receipts and Expenses of Lines per Passenger Mile

While the receipts per passenger mile on any line may be comparatively small, the density of traffic may be such that the operating expenses per passenger mile, are correspondingly small and the operation of the line may be profitable even though the average haul is long.

In order to determine with present rate of fare the greatest length to which the Company can operate its lines and extend its transfer privileges without actual deficit of operation, excluding fixed charges, the relation of operating expenses to receipts per passenger mile is of value. This relation has been computed for each line and likewise the length of ride for which the operating expenses equal the passenger receipts. On all rides, of less than this length, the Company realizes net earnings to apply against its fixed charges, although in many cases not to their entire amount. The operating expenses per passenger mile are calculated for each line by dividing the average operating expenses per car mile of the surface system for the fiscal year 1910 by the average number of passengers per car of that line. This is not strictly accurate as between lines, because of variations in speed, weight

and kind of cars. Within limits, however, it furnishes an instructive comparison. The ratio of operating expenses to passenger receipts per passenger mile, by groups of lines is as follows:

RECEIPTS AND OPERATING EXPENSES PER PASSENGER MILE

	Passenger Receipts (For Composite Day of Riding Count Aug. 29–Sept. 22, 1910)	Operating Expenses (Based upon Average per Car Mile for year to June 30, 1910)	Per Cent Operating Expenses to Passenger Receipts
Lines from Delivery District to:			
Northeast	1.61¢	0.87¢	54%
North Philadelphia	1.95	0.96	49
North Suburbs	1.09	0.78	72
South Philadelphia	2.33	1.00	43
West Philadelphia	1.78	1.05	59
Average Delivery District Lines (Surface)	1.72	0.93	54
Crosstown Lines:			
West	2.23	1.32	59
South	2.35	1.43	61
North	1.88	1.21	64
Average Crosstown Lines	1.98	1.26	63
Average, Surface System, without Suburbs	1.75¢	1.00¢	57%
Subway-Elevated	1.27	0.62	49

The suburban lines have not been shown because their operating expenses per car mile vary too greatly from the average for the surface system. It is interesting to note that the length of routes and density of traffic are such that the length of a passenger's ride may exceed the length of haul for which operating expenses equal receipts on 5 lines out of 7 to the Northeast, on 13 lines out of 19 to North Philadelphia, on all lines to the North Suburbs, on 1 line out of 17 to South Philadelphia, on 17 out of 17 to West Philadelphia and on 23 out of 26 crosstown lines. This means that on 65 lines out of 92, counting double-end lines as two each, many passengers ride who do not pay operating expenses, without considering in the cost of operation, taxes, interest and depreciation on the investment required in their service.

Average Conditions shown by Count

To show that the volume and distribution of traffic was normal and representative during the period of the general passenger count from August 29 to September 22, 1910, the total passengers carried by each line on the day counted, are compared with the average daily number for the period (Saturdays, Sundays and holidays excepted) and with the daily average for the fiscal year ending June 30, 1910

(strike period deducted). The variations from these averages by groups of lines are as follows:

RATIO OF TRAFFIC ON COMPOSITE DAY OF COUNT TO AVERAGES FOR COUNT PERIOD AND FOR YEAR 1910

	Ratio of Day Counted to Daily Average for Period Aug. 29 to Sept. 22, 1910	Ratio of Day Counted to Daily Average for 1910 (Less Strike)
Double-end Lines North and South:		
Northeast to South Philadelphia	99%	106%
North Suburbs to South Philadelphia	105	100
North to South Philadelphia	95	101
Average Double-end Lines	98	102
Lines Terminating in Delivery District from:		
Northeast	103	106
North Suburbs	104	101
North Philadelphia	103	108
Average from North	103	105
South Philadelphia	93	104
West Philadelphia	99	104
Subway-Elevated	98	107
Average, Lines Terminating in Delivery Dist.	100	105
Crosstown Lines:		
West	98	113
South	100	117
North	98	102
Average Crosstown Lines	98	107
Suburban Lines	105	106
Average, all Lines	100%	105%

This demonstrates that the fluctuations of traffic during the period of the count were not important, and that the results obtained from the count may be considered representative of normal traffic.

Location and Destination of Transfers and Exchanges

About 20% of the 5¢ passengers or 220,000 per day, use free transfers which are issued principally between lines intersecting well outside of the central or delivery district. Approximately 6% of the 5¢ passengers or 63,000 per day, use 3¢ exchanges. These are issued principally between lines intersecting in and near the delivery district.

For each day of the general passenger count, the transfers and exchanges collected by each line counted, were assorted according to lines issuing and direction. The free transfers collected, are shown by diagram in Volume II which gives the number of transfers for the day, at all points where there were more than 10 transfers. This diagram shows clearly the distribution of free transfer business, the

greatest volume being in the northern part of the city above Columbia Avenue and in West Philadelphia to and from the subway-elevated line.

Transfers were used in various parts of the city as follows (neglecting quantities under 10 at any intersection):

	Transfers Collected Both Directions	Per Cent of Total
Northeast	27,440	12%
North	86,385	39
South	27,993	13
West	66,323	30
Delivery District	3,898	2
Between subway-elevated and subway-surface	9,577	4
Total (neglecting quantities under 10)	221,616	100%

The large transfer movements were:

In the Northeast, from north to west	5,603
In the North, from east to south	17,432
In the North, from north to east	9,699
In the South, from west to north	6,113
In the West, from east to north	13,157
In the West, from east to south	14,252

and in the reverse directions.

Important transfer points and the number of passengers in the direction of greatest movement, where 1,000 or more, are as follows:

From the		Line or Street	To the		Line or Street	No. of Transfers
East	on	Olney Ave.	South	on	Old York Road	1,057
West	"	" "	"	"	Frankford Ave.	1,122
East	"	Allegheny Ave.	"	"	Frankford Ave. / Kensington "	1,270
"	"	" "	North	"	Germantown Ave.	1,220
"	"	" "	South	"	10th St.	1,580
"	"	" "	"	"	15th "	1,233
"	"	Lehigh Ave.	"	"	" "	1,685
West	"	" "	"	"	" "	1,006
South	"	Berks & Montgomery	North	"	Frankford Ave. / Kensington "	1,384
North	"	Frankford Ave. / Kensington "	South	"	Berks & Montgomery	2,345
West	"	Girard Ave.	North	"	N. 19th St. Lines	1,087
East	"	" "	South	"	60th St.	1,163
"	"	" "	"	"	52nd "	2,423
South	"	52nd St.	East	"	Girard Ave.	1,886
North	"	17th & 20th Sts.	West	"	" "	1,355
South	"	60th "	East	"	" "	1,172
North	"	Germantown Ave.	South	"	10th & 11th Sts.	3,333
South	"	10th & 11th Sts.	North	"	Germantown Ave.	1,315
North	"	Ridge Ave.	South	"	17th & 19th Sts.	2,450
"	"	17th & 19th Sts.	West	"	Lehigh Ave.	1,201
"	"	Germantown Ave.	South	"	18th & 20th Sts.	1,381
North	"	" "	East	"	Allegheny Ave.	1,462
"	"	Torresdale	South	"	Frankford Ave. / Kensington "	2,494
South	"	Frankford Ave. / Kensington "	North	"	Torresdale	2,591
North	"	18th & 19th Sts.	South	"	17th & 18th Sts.	1,572
West	"	Passyunk	North	"	3rd St.	1,082

Between the subway-elevated and the surface lines, 42,173 passengers transferred as follows:

	Subway-Elevated Eastbound	Subway-Elevated Westbound
North of Market Street		
63rd St.	1,146	1,205
58th & 60th Sts.	3,454	3,477
52nd St.	5,209	4,085
Bala.	....	960
Total North of Market St.	9,809	9,727
South of Market St.		
58th & 60th Sts.	1,783	3,078
52nd St.	3,053	3,330
Chester Ave.	1,232	584
Total South of Market St.	6,068	6,992
Total West Philadelphia	15,877	16,719
City Hall	6,203	3,374
Total	22,080	20,093

Exchange tickets are sold at 3¢ for use on so many different lines, and the numbers at each junction point are so small, that the various lines have been grouped in zones extending east and west, and north and south, corresponding in general to the zones or belts of conventional sections used for the study of routing. A summary of the exchanges in one direction, neglecting quantities under 10, and covering 21,816 exchanges shows:

	Exchange Tickets Collected	Per Cent. of Total
From West to North	7,934	36%
East to North	4,206	20
West to South	5,548	25
East to South	4,128	19
Total	21,816	100%

10,710 (or 49%) passengers exchanged north of the delivery district; 7,290 (or 33%) exchanged in the delivery district principally from West Philadelphia lines, and 2,159 (or 10%) from the direction of the ferries; 1,657 (or 8%) of the exchanges took place in South Philadelphia.

Rush-Hour Cordon Counts

The main business delivery district including centers for shopping, wholesale business, offices, hotels, railroads and ferry stations and amusements, as stated is a rectangular area, bounded north and south by Cherry and Locust Streets, east by the Delaware River and west by 17th Street.

On Wednesday and Thursday, October 5th and 6th, between the hours of 4 and 7 p. m., "cordon" counts were made, of passengers traveling on all lines into and out of this delivery district. In order to obtain records of maximum loads, as far as possible, the cordon was drawn beyond the limits of the delivery district, to Spring Garden Street on the north and to Pine Street on the south, with 17th Street the western, and the Delaware River the eastern boundaries, making 36 points of observation. An observer was stationed at each point where a car route crossed the cordon to record passengers, line and time of each car. For October 6 similar information for the entire city as to steam railroad and ferry traffic was furnished by the Pennsylvania

Railroad Company, the Philadelphia & Reading Railway Company and the Baltimore & Ohio Railroad Company. All of this information was compiled by half hour periods and the total traffic on each street for the entire period covered is shown by diagram in Volume II. Another count of the surface street railway passengers going out of the district between 4 and 7 p. m., was made for a composite day of the five week days except Saturday, before Christmas, or from December 19 to 23, 1910, and the results are shown on an accompanying diagram.

The traffic passing the cordon on each street and to each part of the city was as follows:

RUSH-HOUR TRAFFIC FROM DELIVERY DISTRICT, 4 TO 7 P. M.

	On Wednesday, Oct. 5, 1910	On Composite Day, Dec. 19-23, 1910
To North:		
3rd Street	4,868	4,822
5th "	7,317	6,119
8th "	10,577	9,661
9th "	3,146	2,660
11th "	11,639	8,991
Ridge Avenue	5,050	5,319
13th Street	9,015	9,040
16th "	2,895	2,948
18th "	2,038	3,555
19th "	3,673	3,191
Arch "	3,052	3,560
Callowhill Street	204	221
Spring Garden Street	885	1,465
Total to North	64,359	61,552
To South:		
2nd Street	2,543	2,277
4th "	2,427	3,292
6th "	6,188	5,558
7th "	1,802	2,383
10th "	3,285	2,947
12th "	3,511	4,246
15th "	4,158	3,810
17th "	3,597	3,275
19th "	1,988	2,523
Total to South	29,499	30,311
To West Philadelphia:		
Spring Garden Street	1,684	1,488
Arch Street	2,200	1,821
Market Street	11,689	13,336
Walnut Street	6,665	6,801
Pine Street	3,075	3,153
Total to West (surface)	25,313	26,599
Subway-Elevated	18,025	....
Total to West	43,338	....
Total Surface	119,171	118,462
Total Surface and Subway-Elevated	137,196	....

The close correspondence between the figures for October and December indicates that rush-hour traffic is comparatively regular. It

will be noted that where in general the traffic in December is more on one street, it is less on adjacent streets. The greatest differences are that the number of passengers north on 5th, 8th, 9th and 11th Streets was about 18% less in December than in October, while the number west on Market was about 14% larger in December.

The average car loading was as follows:

AVERAGE CAR LOADS PASSING CORDON OCTOBER 5, 1910, 4 TO 7 P. M.

Lines to	4 to 4:30	4:30 to 5	5 to 5:30	5:30 to 6	6 to 6:30	6:30 to 7	Av'ge for 3 Hours
Northeast	23	27	46	68	64	28	43
North Philadelphia	23	32	48	62	59	25	44
North Suburbs	38	51	68	80	77	33	60
South Philadelphia	16	21	37	60	59	39	39
West Philadelphia	25	33	48	64	56	27	44
Average	23	30	46	64	60	32	44

The average car loads during half-hour periods exceeded the comfortable capacity of the cars, calculated as the seating capacity plus standing capacity at four square feet per standing passenger, on lines as follows:

AVERAGE LOAD FOR HALF-HOUR PERIODS EXCEEDING CALCULATED CAR CAPACITY OCTOBER 5, 1910, 4 TO 7 P. M., AT CORDON

		5 to 5:30	5:30 to 6	6 to 6:30	Length or Type of Car	Calculated Capacity of Car
Lines to Northeast						
78	Bridesburg		56	57	18′	48
4N	Richmond, 7 & 9	61	88	93	20′	52
69	Tioga & Dock		49		18′	48
67	Berks & Montgomery		73	70	24′	61
72N	Frankford, Berks 5 & 6		81	81	24′	61
73N	" Lehigh 5 & 6		84	65	24′	61
Lines to North Philadelphia						
56	Franklinville	56	66	68	20′	52
34	Norris & Susquehanna	53	62	61	20′	52
53N	Indiana	54	64	51	18′	48
33	Cambria, 7 & 9		60		18′	48
32	10 & 11		77	77	Pay-Within	76
47N	Cumberland		76		"	76
48N	13 & 15			101	"	76
38	Manayunk		63	68	24′	61
44	Ridge		70		24′	61
Lines to North Suburbs						
54N	Fox Chase	55	74	63	20′	52
63	Willow Grove, 4 & 8	77	97	90	12 Bench Center Aisle Open	54
64	" " 13 & 15		77	94	Pay-Within	76
58N	Chestnut Hill		83		"	76
60	Pelham		78		"	76
49N	Wayne		83	92	"	76
Lines to South Philadelphia						
72S	Frankford, Berks, 5 & 6	(6th St.)	89	65	24′	61
73S	" Lehigh, 5 & 6	(6th St.)	76		24′	61
54S	Fox Chase	(6th St.)	65	57	20′	52
4S	Richmond, 7 & 9	(6th St.)		64	20′	52
48S	13 & 15	(15th St.)		79	Pay-Within	76
1S	12 & 16	(12th St.)	78	81	Pay-Within	76
Lines to West Philadelphia						
16	Elmwood		80	76	20′	52
26	Belmont		50		18′	48
27	Haddington-Hestonville		51		18′	48
28	Overbrook	60	55		18′	48

Rush-Hour Passengers and Service from Delivery District

A statement of the half-hourly totals from these counts, has been prepared and is included in Volume II, to show the relation between passengers, cars, seats, and seating and standing capacity during each half hour.

The total number of passengers outbound by surface cars from 4 to 7 p. m. (excluding the Race, Beach and Callowhill Lines) was 118,400 on October 5, and 117,544 in December. The total service was as follows:

RUSH-HOUR SERVICE AND TRAFFIC FROM DELIVERY DISTRICT, SURFACE SYSTEM

	Three Hours, 4 to 7 P. M.		Heaviest Half-Hour	
	On Wednesday, Oct. 5, 1910	On Composite Day, Dec. 19-23, 1910	On Oct. 5, 1910 5:30 to 6 P. M.	On Composite Day, Dec. 19-23, 1910 6 to 6:30 P. M
Number of Cars	2,719	2,527	503	458
Number of Seats, Regular Winter Car Assignment	90,776	84,444	16,722	15,310
Seating and Standing Capacity (allowing 4 sq. ft. per standing passenger)	178,695	166,226	32,759	30,070
Passengers Outbound	118,400	117,544	32,236	27,395

The average number of passengers per car for the entire rush-hour period of October 5, was 44, varying by half hour periods from 23 to 64. The average for the December observations was 47, varying from 27 to 64. On October 5 there were 131 passengers for 100 seats during the entire period, or 193 passengers for every 100 seats during the heaviest half hour. In December there were 139 passengers per 100 seats for the entire period, and 190 during the heaviest half hour. The total seating and standing capacity for the heaviest half hour slightly exceeds the number of passengers on each day. These figures are of use only in studying the total volume of business, and its variation by half hour periods. The total car service required on each line cannot be proportioned from the sum of the passengers on all lines because the heaviest half hours are not coincident, and because the maximum loading points on many lines are beyond the limits of the delivery district. Also in proportioning service there will be a fractional load on each line. These fractional loads of course cannot be combined so that the number of cars required is greater than the total traffic indictates as necessary. On many lines also where traffic is light the limit of car capacity is seldom reached.

Income Account of Extra Rush-Hour Cars

The total passengers carried out of the delivery district by surface cars from 4 to 7 p. m. constitute 24% of all passengers carried one way in 24 hours on the lines operating in the delivery district, and the number to be handled during the maximum hour is about 2.89 times the average per hour during the intermediate hours. This flood of traffic presents one of the most difficult problems of urban transportation. It comes at a time of day when the streets are most congested with other traffic. The peak is short and sharp, and largely in one

direction, so that the equipment necessary to handle it can seldom be used for more than one full load.

The bearing of this limitation may be understood by considering the financial results from one extra or tripper car. If this is a 28-foot motor car, with allowable capacity of 76, calculated at the seated load and 4 square feet per standing passenger, it might carry a full load one trip and a seated load one trip both morning and evening. Its receipts at the average of 4.14¢ per passenger would be $8.88 per day, or for 300 days $2,664. The cost of operation of each additional car making four round trips of average length, per day, at approximately $1.00 per car hour would be $1,884 per year. Interest, taxes and depreciation at 10% on an investment of approximately $15,000 per car covering car, power, shop and storage, would be $1,500. Its income account per year without considering its proportion of fixed charges on investment in track and overhead line, would be approximately:

ANNUAL INCOME ACCOUNT OF AN EXTRA RUSH-HOUR CAR

Receipts	$2,664
Operating Expenses	1,884
Net Earnings	780
Interest, Taxes and Depreciation (10%) on Cars, Power Plant, Car Houses and Shops	1,500
Loss	$720

This loss is of real interest to the public because the less a company loses on rush-hour service, the more it can be expected to extend its lines, to increase the length of ride for one fare, to provide frequent service at non-rush hours, and to discard its old equipment.

Traffic at Points of Maximum Loading

The service on each line should be based primarily on the traffic passing the maximum load point during the heaviest half hour on that line. This heaviest period varies between lines, being earlier on some and later on others. The total traffic upon which service should be based is, therefore, the sum of the traffic for such greatest half hours by lines. This is shown in comparison with the greatest simultaneous half hour's traffic passing the cordon, and that at points of maximum load as follows:

EVENING RUSH-HOUR SURFACE PASSENGERS, OCTOBER 5, 1910

	Total for Three Hours, 4 to 7 P. M.			Heaviest Half Hour			
	Passing Cordon A	At Points of Maximum Car Load B	Ratio B to A	Passing Cordon 5:30 to 6 P. M. C	Same Cars at Points of Maximum Load D	Summation of Heaviest Half Hour Traffic on Each Line E	Ratio E to C
Lines to							
Northeast	14,166	15,359	108%	3,929	4,412	4,412	112%
North Philadelphia	35,612	40,210	113	10,286	11,605	11,971	116
North Suburbs	13,810	15,395	111	3,693	4,171	4,418	120
South Philadelphia	29,499	30,977	105	7,865	8,103	9,247	118
West Philadelphia (Surface)	25,313	27,213	108	6,463	6,918	7,878	122
Total	118,400	129,154	109%	32,236	35,209	37,926	118%

For lines which do not touch the delivery district, similar statistics were obtained during the period of general passenger count from August 29 to September 22, confirmed by observations during July and August.

Limitations of Rush-Hour Service

The problem further involves the determination of a reasonable standard of car service for the rush hours, and the definition of practicable rules for car loading. The extreme limits of such service would be, on the one hand, to provide seats for all passengers, and on the other to continue the midday car service through this busy period. The maximum number of cars which can be operated is absolutely limited by track and crossing capacity, and the necessity of providing sufficient employment for the extra car men.

The track as now operated in the delivery district of Philadelphia has not yet been used to its greatest capacity except on some streets. An efficient re-routing of lines, the replacement of present small cars by large motor cars, and the use of large trailers, if practicable, would make possible a considerable increase of service in this district.

The Company now schedules in winter about 39% more cars, and in summer about 45% more cars, during the evening rush hour, than on its base schedule during the middle of the day. Other large American street railway systems operate as many as 100% more cars during the rush hours than on the base schedule, which proves the feasibility of at least doubling the service during the rush hours with single car operation. With the use of large trailers it is believed that a still larger proportion of rush-hour capacity would be found practicable.

On the other hand, however, there are conditions of finance in the broad sense which place an economic limit upon the amount of car service than can be operated at this time of day. Track and street capacity must also be conserved as far as possible, in the interest of speed of operation.

Reasonable Car Loading

Looking at the problem from another standpoint, if the service is proportioned upon the number that the car can accommodate comfortably, both seated and standing, the car capacity would be used most efficiently and overcrowding would be prevented.

From careful studies of car capacities, it has been found that four square feet of aisle and platform space per standing passenger allows comfortable standing space. This would mean, for the Philadelphia Pay-Within car, two rows of standing passengers with sufficient space for passage between, and a total capacity of 76, of whom 38 would be seated and 38 standing. In other words, for a car with longitudinal or lengthwise seats, the standing capacity would equal the seating capacity. For a cross-seat car like those now operated in Philadelphia with seating capacity of 40, the standing capacity would be 29 and the total 69. If the usual large prepayment platforms are used on the cross-seat car it would accommodate 36 standing passengers, or with the seated passengers a total of 76. Therefore, applying this rule to the cross-seat car, the standing capacity would equal from 60% to 90% of the seating capacity. This standing load is practically within the limits used by other American street railway companies which have given attention to

the subject, and as prescribed in some cases by governmental regulations abroad.

This is believed to be a reasonable limit of car loading and has been used in the calculations and recommendations for rush-hour service.

In accordance with these rules the capacities of the principal types of winter cars used in Philadelphia are as follows:

Car Capacity

ESTIMATED CAPACITY OF PRINCIPAL TYPES OF WINTER CARS

Class of Car	Seats	Standing Space at 4 Sq. Ft.	Total Capacity
28′ Longitudinal Seat, Pay-Within	38	38	76
28′ Cross Seat	40	29	69
24′ Maximum-Traction Truck	32	29	61
20′ Single Truck	26	26	52
18′ Single Truck	24	24	48
28′ New Standard Cars Suggested	40	36	76

Limits to Individual Car Loads

In order to prevent or lessen periodical overcrowding caused by the bunching of cars or passengers, it is desirable to limit the loading of cars to the standard capacity determined. This under ordinary conditions of operation can be accomplished with platform doors or gates which close the entrance and exit when the car is in motion, together with the use of the "car full" sign.

The reasonable use of the individual car limit and the "car full" sign has been found beneficial by the American companies that have adopted it. This largely does away with the uncomfortable, unsanitary overcrowding, so common at present in many American cities at rush hours, and facilitates the speed and regularity of operation by eliminating the most serious cause of bunching of cars. Such a definite notice also reduces the annoyance of being passed by the motorman.

Efforts to restrict car loading to standards sometimes used abroad have met with objection because the limit has been placed at or near the seating capacity. This is impracticable under American conditions. During the non-rush hours, however, seats should be provided for all passengers. As the traffic increases at the beginning of the rush hours sufficient cars to furnish seats should be added until the maximum schedule is in operation.

Recommended Rush-Hour Service

It is, therefore, recommended that rush-hour service in accordance with the above standards should be furnished, and that individual car loads should be limited on a practicable plan with allowance for extraordinary conditions.

Improved Service Practicable Immediately

As the present rush-hour service is considerably below the standard recommended, this plan cannot be put into effect until additional cars and power are secured.

During the time of construction of additional equipment, it is recommended that the Company operate a service, as far as the num-

ber of present cars and the capacity of its power system will permit, which will provide on each line during the busiest half-hour an *average* car loading equal to the recommended standard of maximum car capacity.

Although this would result in a considerable improvement of car loading, maximum loads up to the crowding limit of the cars, would still be carried regularly.

Recommended Service Applied to Traffic of October, 1910

From a large number of observations in Philadelphia and elsewhere, it is found that in a half-hour period the maximum car loads on any line are approximately 25% greater than the average. If the "car full" regulation is used, the average car loading would therefore be about 80% of the comfortable capacity, in accordance with this rule.

The headway or number of cars which must be run past the point of maximum loading on each line has been calculated from the number of passengers for each half hour. From the headway required and the length of line, the number of cars necessary to provide the service is determined. As it is recommended that trippers use short or turnback routes wherever possible, the cars required are figured on that basis. Beginning with the base or non-rush hour schedules, cars should be provided sufficient to furnish seats for all passengers until the headway required at the heaviest half hour has been reached. The minimum headway should then be continued through and after the peak of the load until the number of passengers again equals the seating capacity. To furnish service in accordance with above standards, the following numbers of cars in operation would be required to accommodate the traffic observed:

Cars Required

NUMBER OF EVENING RUSH-HOUR CARS REQUIRED TO BE OPERATED FOR WINTER SCHEDULES

Lines from Delivery District to	Reported by Company November. 1910	To Provide Seats for All with Present Types of Cars	Immediate Service Practicable with Present Equipment (Average car load in heaviest half hour equals capacity of car)	Recommended Service with Additional Equipment (Maximum car load equals capacity of car)
Northeast	159.0	361.0	234.7	259.7
North Philadelphia	440.2	773.1	495.1	579.3
North Suburbs	181.3	362.8	256.8	279.1
Total to North	780.5	1,496.9	986.6	1,118.1
South Philadelphia	220.0	384.3	223.5	267.5
West Philadelphia	314.0	541.0	362.0	415.0
Total from Delivery District	1,314.5	2,422.2	1,572.1	1,800.6
Crosstown Lines:				
West	73.0	116.2	64.3	75.9
South	44.5	92.6	52.6	61.5
North	204.0	383.0	261.0	288.0
Total Crosstown Lines	321.5	591.8	377.9	425.4
Suburban Lines	36	48	37	39
Total Surface System	1,672	3,062	1,987	2,265

Double end lines are treated as if divided at Market Street, causing fractions of cars in districts served by such lines.

If 2,265 cars were operated at the rush hours, there would be 89% more cars in service than in the middle of the day on the base schedule in force last October. This is within the limits of American practice. It is estimated that this service, for both morning and evening rush-hours would result in additional car mileage of about 11%, or an increase in operating expenses of about 9%. Even with this increase, however, the car mileage of the surface system would be less than was operated in 1907.

Additional Cars Required in Operation

With present methods of operation and with the present car equipment, supplemented by new cars, 593 more cars would be required in operation than are provided by the present winter schedules. The Company reports that trippers are placed in service to a certain extent, as needed, and that the number varies from day to day. The actual number of cars in use on October 5 agrees substantially, however, with the schedules reported. The number of cars required for the summer schedules as reported is about 7% in excess of the number reported for winter, which indicates that the deficiency in summer is somewhat less than in winter.

Additional Cars Required

The number of additional cars required depends upon the size of cars used. It is assumed that the types of cars now in use on each line will be retained as far as the present cars owned will go, and that some lines will be equipped with new cars throughout. The Company has a large surplus of 18-foot cars, but the extension of use of these small cars to additional lines is not proposed. This permits the selection of the best of the small cars for operation, leaving the remainder for reserve. The desirability of discarding many of the single-truck and maximum-traction cars here assumed to be used, is a question affecting the economy of operation, and should be left to the Company. For many important reasons set forth elsewhere it should be determined whether the use of trailers at the rush hours is generally practicable in Philadelphia, as if so, about one-half of the new cars required might be of this type.

The above recommended standard of service would necessitate the purchase of 465 new cars for service and 5% additional for inspection and repair, a total of 489. It is probable that the use of "car full" signs would tend slightly to reduce the fluctuations of load and consequently reduce slightly the number of cars required, as of October, 1910. The amount of such reduction can only be demonstrated by the test of actual service.

Future Car Service

The number of additional cars stated above to be required for surface operation should be considered as an example of the rules recommended, not as the present requirement. It was the number necessary in October, 1910. The traffic is continually increasing and

with the broader plans which have been proposed, the rate of increase should be more rapid in the future. The car equipment calculated to have been necessary for last October with the additional power equipment, would require probably a year for purchase and installation, and by that time, still more cars and power will be needed. Consequently these standards of car loading and car service should be adopted in principle, and should be applied by a bureau or department to be established by the Company. Based on the periodical determinations of this department, the Company should estimate and provide for its car and power requirements from one to two years in advance.

Non-Rush-Hour Service

The study of traffic and service has been devoted principally to the evening rush hour, as this is the most serious problem. By a series of counts from 10 a. m. until 2 p. m. made principally in December, 1910 and January, 1911, it was found that the number of cars at non-rush hours is ample to handle the business. The headways calculated from the figures thus obtained are based upon furnishing a seat for every passenger during the heaviest half hour of the period covered, using the factor of 80% to allow for fluctuations of loading. These figures show that on the days of observation 48 lines provided more than enough seats to satisfy this requirement. On 24 lines the service was sufficient and on 18 lines the necessity of a more frequent headway was indicated. In this statement the suburban lines are not included, and the double end lines are counted as two lines each.

Hourly Variation of Cars in Service

On the composite day of the general passenger count, the number of cars in service at different hours was as follows:

Cars in Service at Various Hours

	4-5 A. M.	8-9 A. M.	11-12 A. M.	5-6 P. M.	11-12 P. M.
Lines from Delivery District to:					
Northeast	37.7	163.9	122.1	176.0	98.5
North Philadelphia	56.0	375.7	275.9	433.7	222.2
North Suburbs	48.4	167.6	155.5	202.6	184.6
South Philadelphia	36.1	179.6	152.1	200.5	122.3
West Philadelphia	59.	313.	233.	334.	163.
Total from Delivery District	237.2	1199.8	938.6	1346.8	790.6
Crosstown Lines:					
West	15.4	64.7	54.7	68.7	43.4
South	10.4	42.5	39.7	42.5	36.
North	49.	195.	175.	230.	163.
Total Crosstown	74.8	302.2	269.4	341.2	242.4
Suburban	13	40	40	40	36
Total Surface System	325	1542	1248	1728	1069
Subway-Elevated	0	88	57	96	26
Total	325	1,630	1,305	1,824	1,095

In percentage of the number of cars in service between 11 and 12 A. M., which may be regarded as the base schedule, the above figures are as follows:

RATIO TO BASE SCHEDULE

Lines from Delivery District to:	4-5 A. M.	8-9 A. M.	11-12 A. M.	5-6 P. M.	11-12 P.M.
Northeast	31%	134%	100%	144%	81%
North Philadelphia	21	136	100	157	80
North Suburbs	31	108	100	130	119
South Philadelphia	24	118	100	132	80
West Philadelphia	26	138	100	148	72
Total from Delivery District	25	119	100	143	84
Crosstown Lines:					
West	28	118	100	125	79
South	26	107	100	107	91
North	28	112	100	132	93
Total Crosstown	28	112	100	127	90
Suburban	33	100	100	100	90
Total Surface System	26	124	100	138	86
Subway-Elevated	.....	154	100	168	46
Total	25	125	100	140	84

From this statement it is seen that the greatest number of extra or tripper cars in proportion to base schedule cars, was operated on the lines to North Philadelphia and the surface lines to West Philadelphia in the morning; and on the lines to North Philadelphia in the afternoon. On the surface lines the morning tripper cars were 24% of the base schedule cars, and the evening trippers were 38%, while the corresponding figures for the subway-elevated are 54% and 68%.

The number of base schedule cars on the surface system, 1,248, compares with 1,226 reported by the Company as regularly scheduled. The morning maximum was 1,542 compared to 1,620 and the evening maximum 1,728 compared to 1,814.

Comparative Capacity of Summer and Winter Cars

A comparison of the capacity of summer and winter cars is shown on the statement of present car assignment and lines. A summary of this statement by groups of lines, giving the figures for cars as reported by the Company, and as observed in September is as follows:

MAXIMUM CAR CAPACITY OPERATED AT EVENING RUSH-HOUR

	SUMMER			WINTER	
	Reported by Company, June, 1910		Observed Riding Count Aug. 29-Sept. 22	Reported by Company, November, 1910	
Lines from Delivery District	Seats	Seating and Standing Capacity	Seats	Seats	Seating and Standing Capacity
Northeast	7,749	11,052	7,567	4,680	9,046
North Philadelphia	18,089	29,501	17,926	14,321	28,217
North Suburbs	7,364	12,546	7,459	6,141	12,282
South Philadelphia	8,853	15,286	8,736	7,551	14,971
West Philadelphia	13,858	23,358	13,754	10,804	20,886
Total from Delivery District	55,913	91,743	55,442	43,497	85,402
Crosstown Lines					
West	3,094	4,774	3,118	2,164	4,328
South	1,516	2,263	1,612	1,068	2,136
North	10,758	16,988	10,402	6,136	12,273
Total Crosstown	15,368	24,025	15,132	9,368	18,737
Suburban	1,872	2,510	1,765	990	1,938
Total Surface System	73,153	118,278	72,339	53,855	106,077

This statement shows that the actual seats operated on average week days agree closely with the number calculated from the schedules reported. The total seats operated in winter are 28% less than the

number operated in summer, while the total capacity allowing four square feet for each standing passenger, is only 12% less. The ratio of total capacity to standing capacity for cars used in summer is 162% and in winter 197%.

Load Zones

The comparative extent of the waves of traffic from the delivery district is shown by a tabulation of "Load Zones," giving for each line the point of maximum loading, and the points beyond which, 80% 50%, 30%, and 20% of the maximum loads are carried. By groups of lines the simple averages of the width of such zones are as follows:

LOAD ZONES

DISTANCE (MILES) FROM MARKET OR 9TH STREETS

Lines from Delivery District to:	Maximum Load Points	80%	50%	30%	20%
Northeast	1.3	3.7	4.8	5.2	5.6
North Philadelphia	1.1	2.1	3.2	3.7	4.0
North Suburbs	2.5	4.9	7.3	8.1	8.4
South Philadelphia	0.4	1.1	1.7	2.0	2.3
West Philadelphia	1.6	2.9	4.2	4.8	5.0

During the heaviest rush-hour the 50% column represents approximately the standing zone or the average distance through which some passengers are obliged to stand.

Use of Delivery District Trackage

The maximum number of cars per hour operated per track in the delivery district as per schedules and routes in force on June 30, 1910, and during the period of observation was as follows:

MAXIMUM NUMBER OF CARS PER HOUR PER TRACK IN DELIVERY DISTRICT

	By Schedules and Routes of June 30, 1910	Rate per Hour as Observed in 10 Minute Periods (Principally on October 6, 1910)
East Bound:		
Arch Street	124	156
Market Street	91	114
Chestnut Street	109	114
West Bound:		
Arch Street	121	132
Market Street	91	114
Walnut Street	139	144
North Bound:		
3rd Street	65	90
5th "	55	78
8th "	80	108
9th "	133	144
11th "	52	150
13th "	48	106
16th "	24	48
South Bound:		
2nd Street	75	86
4th "	80	120
6th "	73	90
7th "	82	102
10th "	98	130
12th "	39	93
15th "	48	94

Under the schedule of June 30, 1910, there was at times congestion on Walnut Street, and two lines having 30 cars per hour have since been changed to run west on Market instead of on Walnut Street, making the maximum cars scheduled west on Market, 121 per hour and on Walnut Street, 109 per hour.

Maximum Track Capacity

Experience in other cities has demonstrated that under ordinary conditions, 3 single cars per minute per track can be passed over delivery district trackage. With proper traffic regulation there seems to be no reason why this limit should not be reached on Arch Street and on Market Street excepting at the ferry loop. On Chestnut and Walnut Streets great difficulty of rush-hour operation is experienced, due to the narrowness of the streets and congestion of vehicle traffic and it is probable that not more than about two single cars per minute can be operated efficiently on these delivery tracks. The maximum number of cars passed over a crossing of single track with double track as observed in Philadelphia, was at the rate of 390 cars per hour, or 108 on the single track line, and 141 on each track of the double track line. In other cities as many as 180 cars per hour per track pass over intersections with equal vehicular congestion. The straight track capacity and not the crossings, therefore, would limit the track capacity in Philadelphia. Each of the north and south streets should accommodate at least 120 cars per hour, which would indicate that 9th Street, between Arch Street and Vine Street, is the only one of these streets used to its full capacity at present.

Subway-Elevated Service

The subway-elevated line is designed to carry fully four times the present traffic. Excluding the fixed charges on investment, passengers are transported by this high speed system more cheaply than by the surface system, and it therefore seems desirable to furnish service such as to attract traffic from as wide an area as possible in West Philadelphia. That there is an opportunity for an extension of subway-elevated business is indicated by the passenger count. From a study of the routing and the passenger counts, there is indicated that the preference of systems in reaching the delivery district from the district of West Philadelphia, west of 38th Street and north of Chester Avenue was as follows:

Passengers One Way per Day

Surface	20,575
Subway-Elevated	36,760
Subway-Surface	6,120
Total	63,455

The relative time of transit required from 9th Street to points in West Philadelphia is shown by the following:

Time of Transit (minutes)

From 9th Street	Surface	Subway-Surface	Subway-Elevated
To 52 & Market	27	......	13
To 52 & Baltimore	31	27	18½
To 52 & Girard	31	30	18½

On October 5th and 6th the subway-elevated line carried the following number of rush-hour passengers westward from 15th Street:

Subway-Elevated Rush-Hour Passenger Traffic

	October 5, 1910	October 6, 1910
From 4 to 5 P. M.	3,355	3,880
From 5 to 6 P. M.	9,760	9,980
From 6 to 7 P. M.	4,910	6,035
Total	18,025	19,895

Using 80% as the relation between average load per hour and the maximum load per car, and allowing a maximum load of 107 passengers per car which represents a seated load and 4 sq. ft. for each standing passenger, 120 cars would be required to handle the traffic from 5 to 6 P. M. instead of the 96 cars actually operated. At the time of this record, the Company owned 100 cars and 20 additional cars have since been acquired. The service indicated as necessary for the traffic of October, 1910, would require the use of all the present equipment as no other reserve equipment is available. At least 10% extra or 12 additional cars are needed to allow for break downs and sufficient maintenance and painting in the shop.

The subway-elevated cars are lighted and heated better than the surface cars, the headway or time between trains is less than on the surface, the stops are less frequent and there are no delays on account of street traffic or weather conditions. If ample space for passengers is provided, a larger proportion of traffic will be diverted from the surface lines. This would have the effect of relieving the surface lines of long unprofitable hauls, of relieving congestion on the surface tracks on the east and west streets in the delivery district and of enlarging the use of the subway-elevated line to a point of greater efficiency and return on the investment.

The Company checks the subway-elevated traffic closely and maintains good records of it.

Transportation Inspection and Superintendence

There are many indications that the Company does not check up its surface traffic systematically and carefully to provide for regular movements and fluctuations, and frequently a lack of adequate service for special occasions is noticed. The organization of the transportation department consists of the Superintendent of Transportation and the General Superintendent, who has directly under him the Assistant General Superintendent and 18 division superintendents located at the various operating car barns. Five of these division superintendents at the large barns have one assistant, and three have two assistants. Under the division superintendents are 39 street superintendents; from one to four reporting to each division superintendent. At the rush-hour, there is therefore one street superintendent or inspector to direct the operation of an average of about 40 cars, if all the men are on duty at one time. There is need for approximately 50% more of such men on the Philadelphia system, and they should be given proper authority.

Irregularities of Headway

The irregularities of headway of all cars operated past selected points during the evening rush-hours (4 to 7) have been compiled for

October 5th and for the December observations. A summary by groups of lines follows:

SUMMARY OF IRREGULARITIES OF HEADWAY

Average Time Behind or Ahead (minutes) per Car

	4 to 7 P. M.	
Lines from Delivery District to	Wednesday, October 5	Composite Day, December 19 to 23
Northeast	1.3	3.1
North Philadelphia	1.6	2.5
North Suburbs	1.8	2.4
South Philadelphia	1.5	2.9
West Philadelphia	1.6	3.0
Average Delivery District (Surface)	1.6	2.8
Crosstown Lines:		
West	1.1	
South	1.5	
North	2.3	
Average Crosstown Lines	1.3	
Average Surface System	1.5	

These figures were derived for each line by comparing the time between cars with the average for each hour. The discrepancies were then added together and the average per car derived.

It will be remarked that the irregularities in December were nearly double those in October. The delivery district lines compare as follows:

AVERAGE IRREGULARITY OF HEADWAY

	Number of Delivery District Lines	
	Wednesday, October 5	Composite Day, December 19 to 23
Less than 1 minute	4	0
Between 1 and 1.9 minutes	46	8
" 2 and 2.9 "	14	29
" 3 and 3.9 "	2	18
" 4 and 4.9 "	0	7
5 minutes and over	0	3

In ratio to the regular scheduled headways the irregularities are as follows:

RATIO OF AVERAGE IRREGULARITY OF HEADWAY TO SCHEDULED HEADWAY

	Number of Delivery District Lines	
	Wednesday, October 5	Composite Day, December 19 to 23
Less than 25%	7	1
25% to 49%	44	9
50% to 74%	12	22
75% and greater	3	33

The service on Oct. 5th was comparatively regular, while that observed during the week of December was very irregular.

Causes of Irregularity of Car Service

Irregularities of operation and improper car spacing are serious defects of service and generally result from one of the following causes:

1. Too rapid schedules.
2. Too great length of lines.
3. Carelessness of crew.
4. Abnormal loading.
5. Congestion of street traffic.
6. Railroad grade crossings.
7. Vehicles standing.
8. Vehicles on track.
9. Vehicle accidents.
10. Car accidents.
11. Equipment defects.
12. Slippery rail.
13. Low voltage.

A general consideration of these causes in Philadelphia follows:

1. The schedules in Philadelphia are not in general too fast. There is ample stand time to allow of adjustment. Including stand time the fastest schedule excepting suburban and unimportant lines, is 9.4 miles per hour on the 58th and 60th Streets line and the slowest 6.1 miles per hour on the South 19th and 20th Streets line, the average being 8.0 miles per hour.

2. The causes of delay vary as the length of line. It is therefore generally unsatisfactory to connect a long line on one side of the delivery district with a short line on the other side. The service to South Philadelphia would be improved if all the lines to the north suburbs were operated independently and the southern ends connected with other lines to the north of more nearly the same length and characteristics.

3. It is necessary in every city to drill insistently the newer or slower car operatives to prevent running ahead or avoidable running behind schedule. The general character and attention of the platform men in Philadelphia are excellent, but the maintenance and schedules would be greatly improved by an increase in the number of inspectors or street superintendents.

4. Abnormal loading becomes the principal and most troublesome cause of delays to the cars behind. A car with an overload has to make more and longer stops and it often has to run more slowly. Under the present conditions this is the most serious cause of delay in Philadelphia and every effort should be made to prevent it by devices of routing and schedules, and by vigilant and vigorous work on the street. The use of "Car full" signs and platform doors with sufficient car service would positively prevent this source of delay.

5. The great congestion of street traffic in the central section of Philadelphia should be handled by the city authorities in the most efficient manner. The narrow streets constitute a permanent handicap, but a careful study should be made of each street to determine the best

use that can be made of every available foot of the usual fifty feet between house lines. The proper proportions between sidewalks and roadway should be carefully determined. Encroachments on the sidewalks should be gradually removed. Obstructions such as the subway entrances and poles should be carefully regulated from the standpoint of space occupied. For the benefit of street car riders the paving and kind of rail should be such that wagons will keep off the track, and at many points where the car traffic is continually interfered with, such as at the Chestnut Street Bridge, special tracks or driveways for wagons could be laid. The traffic ordinances should be carefully drawn and rigorously enforced, especially in the main business district. The obstruction of street car traffic by drays backed up to the curb should here be prohibited. Snow should be removed promptly from the business district streets. It must be remembered that in a population of 1,600,000 there are about 1,250,000 riders on the street cars every day. The streets, are, therefore, more used by street car patrons than by vehicle owners.

6. Since the elevation of railroad tracks on 9th Street and on Trenton Avenue there is not an unusual number of grade crossings on the lines of the Company and many sections of the city are practically free from them. A number of grade crossings still exist along Willow Street, American Street and Washington Avenue, where the street railway traffic is heavy and the delays at the rush hour serious. This condition could be greatly improved by a requirement that no steam railroad switching be performed at these places during the rush hours. The Willow Street crossings disarrange the service east of 13th Street on all north and south lines.

10. The statistics of surface car accidents as compiled, show that the Company had in the fiscal year 1910, 23.9 accidents per 100,000 car miles in the nature of collisions. It will be noted that in the boroughs of Manhattan and Bronx, New York City, 9.5 similar accidents per 100,000 car miles occurred, and in Brooklyn 10.7 per 100,000 car miles. These show that the narrow streets in Philadelphia are conducive to accidents of this nature, although the figures for Philadelphia were affected by the strikes.

11. Failures of equipment necessitating "pull-ins" as stated elsewhere in this report, are considerably less in number than in other large cities. The Philadelphia record will be still further improved when some of the old equipment is discarded.

12. Slippery track does not cause unusual delays in Philadelphia. The design of equipment as regards tractive efficiency is good. The tracks are generally well sanded in wet weather, although individual mechanical sanding apparatus should be installed on all cars.

13. No delays on account of low voltage were observed.

Delays during the rush hours can be reduced by careful inspection and supervision on the part of the transportation organization. The street force should be large enough to watch for the first irregularities on each line, and to correct them promptly. All delays should be reported and compiled. These measures must be continuous, not intermittent. The public can render important aid in this work by reporting delays specifically and by promoting sentiment for observance of the traffic regulations.

The Rush-Hour Problem

The heavy rush-hour period produces a maximum daily demand on:

1. Track capacity.
2. Car equipment.
3. Power plant.
4. Electrical distribution system.
5. Platform men (car operatives).

To show the proportions of load and service on the surface system during the evening rush hours, compilations have been made of data concerning the trips beginning in each half hour from noon to 7 P. M. for the composite day of the general passenger count, August 29 to September 22, 1910. The maximum conditions which occur for trips beginning between 5 and 5.30 P. M. compare with those for the half hour from 12 noon to 12.30 P. M. as follows:

Peaks of Traffic and Service

COMPARISON OF EVENING RUSH-HOUR WITH MIDDAY CONDITIONS

	Ratio of Half Hour from 5 to 5.30 P. M., to Half Hour from 12 to 12.30 P. M.
Cars in Service	139%
Car Round Trips	138
Seat Round Trips	155
Seat Mileage	155
Passenger Mileage	278
Ton Mileage of Cars and Passengers	146
Kilowatt Hours Distributed for Average Day of September (5.30 to 6.00 P. M.)	146

There is an absolute physical limit to the number of cars which can be operated over given stretches of track, but cars, power, copper and employes can always be increased, although at the ultimate expense of other features of the service.

Devices for Improving Service

After as many cars as can be reasonably required for the rush-hour traffic, or as many as the track on delivery district streets will accommodate have been put in use, the service can be reinforced by the following devices:

1. Careful timing of trippers to meet heavy loads.
2. Trailers.
3. Turnbacks.
4. Special return routes for trippers.
5. Through routing.

Car Spacing

Cars in use at rush-hours on a given line are commonly spaced at regular intervals all over the line. A study of the traffic by ten-minute periods shows that heavy loads occur shortly after the hour and half-hour points, when many people finish work. If the extra cars or trippers are timed to meet these loads they will be more effective than if spaced evenly on the line. This is now done to some but not to the greatest possible extent.

Trailers

Trailers afford the greatest equipment resource for relieving rush-hour pressure. Track capacity can be increased by as much as 50%, depending on the proportion of trailers used. More seats and standing capacity can be furnished for the same investment in equipment. The weight of equipment per passenger is less, so that the power and distribution requirements are less. For a given number of extra platform men a greater number of cars can be operated. Trailers should have a passenger capacity equal to or greater than the motor cars and should be provided with air brakes and proper safety appliances.

The chief objections to trailers are that they are considered more liable to step accidents, and that they appear to obstruct the streets to a greater extent than individual cars. This greater liability to step accidents can be corrected with gates or doors which close the platforms while the cars are in motion. Collision accidents which vary with the car mileage should be largely reduced by the use of trailers. As to street encumbrance, it is clear that the same number of individual cars starting, moving and stopping, require more room than if run in pairs. There are objections and limitations to the use of trailers from an operating standpoint, largely on account of track clearance conditions and coupling difficulties on curves at narrow street intersections. On some of the Philadelphia lines trailers can undoubtedly be used. Alterations in routes might be warranted in some cases in order to use trailers, or special trailer routes might be operated during the rush-hour to avoid difficult curves. The solution of this problem might necessitate equipping the trailer with motors and designing a special type of car which would increase the passenger space per extra operative. It is best practice to use trailers with tripper cars only, as two-car tripper trains may thus be kept coupled while out of service. The use of trailers at the rush-hours is especially desirable on long lines.

The operating economy of trailers in tripper service is demonstrated by the following estimates of earnings and expenses. In the first column is shown the annual income account of a single motor car, and in the second column the corresponding result for a trailer. It is estimated that each tripper makes two round trips in the morning and two in the evening, carrying a full load one trip and a seated load one trip with allowance for the smaller volume of business at the morning rush.

ESTIMATE OF COMPARATIVE ANNUAL INCOME ACCOUNT OF TRIPPER CARS

	Motor Car	Trailer
Receipts	$2,664	$2,664
Operating Expenses	1,884	1,375
Net Earnings	$780	$1,289
Interest, Taxes and Depreciation (10% on cars, power plant, car houses and shops)	1,500	920
Income (exclusive of return on investment in track and line)	$720 (Loss)	$369 (Profit)

It is thus seen that if motor cars alone are used only a few hours per day, they would operate at a loss which must be made up in some other direction, while a small profit is indicated for trailers.

Turnback Points

At the rush hours it is necessary to secure the greatest service from every car. If the length of line is not too long to permit the car to make a second trip, it is important to get the car back to the loading point as quickly as possible. Trippers should, therefore, not run the full length of the line unless a large proportion of the load goes to the end. The same effect can be obtained by a short branch line operated on the tracks of a regular crosstown line, which may be operated all day or perhaps only at the rush hours. Objection to turnbacks has some foundation during the non-rush hours when the headways are long, but during the flood tide of traffic the car service should be so proportioned as to afford the greatest service to the greatest number.

Special Tripper Routes

Trippers are usually placed on the road between the regular cars and follow the same route from end to end. When one car falls behind therefore at the critical time, those behind it close up and they run more or less in this bunched order for the remainder of the rush-hour period. Sometimes the car ahead is given orders to make every other stop and sometimes it is turned back before reaching the end of the line. This condition can generally be met effectively by turning back all trippers short of both ends of the line, and by returning them to the heavy loading point by a special quick route. This will enable trippers to maintain their schedule when the regular cars are falling behind. The return route can be located over streets where faster time can be made, and the trippers will not, as at present, add to the congestion at terminals.

A good example of the application of this principle is on the Columbia Avenue line. The distance is 4.92 miles from the Market Street ferry to 33rd Street, and the running time is 38 minutes one way, or 7.8 miles per hour. The present winter schedule calls for 21 base cars and 13 trippers, giving headways of 4 minutes at midday and 2.4 minutes at the evening rush-hour. The proposition would be to run the trippers to 29th Street only, 70% of the traffic being east of this point; to use for the return trip 29th Street, Jefferson Street and 4th to Market, at which point the trippers would be turned back into the line west on Market Street, 70% of the traffic on this line originating west of 4th Street. The regular cars furnish ample service from the ferries at all hours and this arrangement would avoid overtaxing the Market Street loop.

For the same number of trippers this service would compare with the present schedule as follows:

Tripper Operation	Present Route	Suggested Route
Length of Round Trip (miles)	9.83	8.72
Time Round Trip (minutes) Including Stand	81	63
Average Headway of 13 Trippers (minutes)	6.2	4.9
Trippers per Hour	9.7	12.2
Seats per Hour of Tripper Service	368	464

There is thus shown an increase of 26% of seating capacity from the same number of trippers, besides securing more regular maintenance of schedule and reducing the use of the east bound Market Street delivery track by the entire number of trippers.

By using a special tripper route for the South 17th and 18th Street line the corresponding possible improvement would be as follows:

	Present Route	Suggested Route (Turnbacks at Jackson and at 8th Streets
Length of Round Trip (miles)	8.10	6.10
Time Round Trip (minutes) Including Stand	72	46
Average Headway of 16 Trippers (minutes)	4.5	2.9
Trippers per Hour	13.3	20.7
Seats per Hour	506	787
Increased utility of trippers	....	55%

By such routes trippers use delivery district tracks in one direction only and if all trippers could be routed in this manner and balanced between the east bound and west bound tracks the number of trippers run through the congested delivery district could be doubled.

Central Car Storage

For handling rush-hour traffic, it is of great advantage to the operation, to have a car-house located near the delivery district. From this it is possible to introduce extra cars where needed to provide promptly for unexpected fluctuations in traffic or irregularities of schedule. A considerable saving in car mileage is effected if the trippers can be stored near the center of the city after bringing in the morning loads, and in out-lying car houses at night after carrying out the homeward traffic. This does not mean that double car barn space would have to be provided for trippers as regular base-schedule cars might use the centrally located car-house at night. In order to determine the operating economy which might result from a car-house so located in Philadelphia, the dead or non-revenue producing mileage under the schedules of June 30, 1910, has been computed, on the basis that mileage is unproductive when it is not required by the volume of traffic or by maximum headway considerations.

By this method, the dead mileage of a tripper includes:

In the morning: First, the mileage from the car-house to nearest point on the line, and second, from the delivery district to the car-house.

In the evening: First, the mileage from the car-house to the delivery district, and second, from the end of the line to the car-house.

The total dead mileage per day as calculated by this method for schedule of June 30, 1910, is 10,612 car miles distributed as follows:

DEAD CAR MILEAGE OPERATED

	Number of Cars	Total Dead Car Miles Operated	Average Dead Car Miles Operated per Car
Base Schedule	1,226	4,843	4.0
Morning Trippers	397	2,221	5.6
Evening Trippers	588	3,548	6.0

The average dead car mileage operated per day per maximum car in service at one time is 5.8 miles. If centrally located storage car-houses could be provided for all trippers, the daily saving would be:

Morning	1,530 Car Miles
Evening	2,024 Car Miles
Total	3,554 Car Miles

This would permit a saving in operating expenses of approximately $120,000 per year, which would represent fixed charges on about $1,500,000. This sum if invested in real estate and facilities for central car storage would be carried by this saving. This investment would be also credited as profit with the annual value of equivalent car storage space located in an outlying district, and also with the use of the real estate above the ground floor, which might be rented for warehouse or other purposes, together with any appreciation of market value of this central real estate.

Summarized Statistics

The scope of the report is so broad and the problems so complex that summaries only of many subjects are given. It is believed that these will be of value to the Company and to students of street railway statistics in further investigations or in the practicable application of the principles involved.

ROUTING

Beginning with omnibus lines and developing by the use of tracks and of various methods of traction to the modern electric trolley system, universal cheap transportation has become the most important factor in the growth of cities and in the every day life of their inhabitants. In large American cities each person rides on an average of three hundred times a year, and a large proportion of the population rides twice a day. The choice of residence, range of employment and method of enjoyment are largely dependent upon the means of getting from one point to another. The enormous modern growth of cities would not have been possible without these improvements in transportation. Their prosperity and further development depend largely upon the facility of street transportation. A community is handicapped if its streets are too narrow for its traffic, or if the vehicle miles or the total miles travelled by its inhabitants each day are not reduced to a minimum by direct and diagonal thoroughfares. With a given street plan and widths utilized to the best advantage by correct proportion of driveways and sidewalks, and by proper traffic regulations and kind of paving, the most efficient method of street transportation is a matter of great public concern.

The street railway routing problem is to provide rapid direct lines between points of travel, arranged to furnish facilities for the entire city, systematically, uniformly, consistently and impartially. If the street railway system could have been originally planned for each city as a whole with these principles in view, the layout of tracks and the routing of cars would be radically different from the present. Enormous waste of competitive effort would have been prevented, irregular and uneconomical development of the building plan would have been avoided, and the public and the corporation would not to-day be confronted with a legacy of superfluous trackage and delivery district congestion. Early consolidations in some cases resulted in great improvement, but a large proportion of American street railways are carrying some part of these burdens today. It is not possible now to adopt a perfect routing design, but there is no system which would not derive benefit from the development of a carefully studied plan, as the basis for changes to be made whenever practicable.

The situation in Philadelphia is:

That those who made the original street plans, not knowing very much of the art of city planning, did not design for 1,500,000 population, or for the amount of traffic or methods of transportation which the streets would be called upon to accommodate.

That in subsequent additions to the city, sufficient attention has never been given to the question of intercommunication.

That the original street railway systems were built up under competitive conditions with little consideration toward providing an adequate, comprehensive or economical service for the city as a whole.

That since corporate consolidation of the car lines, little has been done to correct the original defects.

Present Street Plan

Physically, the spread of the city has been limited to but a small extent so that there are few main arteries of travel as there are, for example, on Manhattan Island. The city is settled thickly and uniformly to the north, west and south. The grades are light, and there have been practically no natural obstructions to development, the Schuylkill River having been readily bridged. That part of the city west of the Schuylkill River is well provided with moderately wide diagonal avenues. Between the rivers, however, there is no relief from narrow streets and right-angled intersections with the exception of Frankford and Kensington Avenues in the Northeast, Ridge Avenue in the Northwest, Passyunk Avenue in the South, Broad Street North and South and Market Street East and West. Of these thoroughfares, those in the Northeast are useful, but do not approach the heart of the city. Ridge Avenue, although narrow, is a striking example of the benefit of diagonal streets. From 32nd and Dauphin Streets to 8th and Arch Streets by way of Ridge Avenue, is 3.14 miles or 26 minutes by car; while by rectangular street distance the route is 4.55 miles and the time 31 minutes. Passyunk Avenue in the south, is too narrow for double track and does not lead to the present business centre.

So long as it is not deemed desirable to use Broad Street for surface car lines, all north and south traffic must divide between narrow parallel streets among which there is little choice except that some are obstructed by parks and some have greater congestion of vehicle traffic.

Traffic of the Delivery District

The main delivery district, including centres for shopping, wholesale business, offices, hotels, railroad and ferry terminals and amusements, is included in the rectangle from the Delaware River to 17th Street and from Locust to Cherry Streets, being about one and one-half miles east and west by one-half mile north and south. Out of an average of 678,000 revenue passengers per day in each direction, 320,000 travel into and out of this district, and about 118,000 of these go out of it during the three-hour period from 4 to 7 P. M. This district is traversed east and west by four streets, two of which are suitable for street railway double tracks, and two for single track and by fourteen streets north and south (exclusive of Broad Street), each accommodating a single track. At three cars per minute on Arch Street and on Market Street, and two per minute on Chestnut and Walnut Streets, the three double lines of track on the east and west streets would accommodate 480 cars per hour in each direction. At two cars per minute the north and south streets would accommodate 840 cars per hour in each direction. If all cars use the limiting sec-

tion of the street upon which they run through the delivery district, the maximum number which could be operated per hour into and out of the delivery district would be 2,160 cars, which, if large cars, would seat approximately 82,000 people. Allowing four square feet of standing space per standing passenger and figuring the average load for the heaviest half-hour at 80% of the allowable maximum, these cars would accommodate about 132,000 passengers per hour. The present maximum movement is about 62,000 per hour. Thus it appears that although this traffic is not equally distributed throughout the district, or throughout the hour, there is opportunity for expansion of rush-hour delivery district traffic and service.

Plans should be prepared, however, for utilizing the streets in this district to their greatest possible efficiency. To this end, careful consideration should be given to operating efficiency, larger cars, use of trailers and to re-routing.

Routing in the Delivery District

The principal consideration in the design of routes in a main delivery district, is that every section of the city shall have equal facilities for reaching any part of the district without transfer. As approximately one person from every residence travels into the delivery district practically every week-day in the year, one should be able to reach any part of it without a long walk. This is not the case in Philadelphia today. Chestnut and Walnut Streets are used almost exclusively for lines to the southern part of West Philadelphia, and for a strip of the city north and south between 17th and 20th Streets, Market Street is used exclusively for lines to the northern part of West Philadelphia with one line to the north-central part of the city. Arch Street offers a greater choice of sections, but is used principally by lines to the northern part of West Philadelphia and to the Northwest. The north and south streets are used for direct north and south travel excepting that the northwestern section is well provided with "L" shaped lines which enter or cross the delivery district at various points. Several L lines also run to the Northeast without system however as to division of territory or of providing choice of delivery.

The principal traffic centers in the delivery district are around the City Hall, 8th and Market Streets, the Delaware River ferries, the wholesale district in the eastern portion and the financial district around Fourth and Chestnut Streets. Manifestly, the best delivery for any line, is lengthways of the district, or east and west, in order to reach as many important points as possible. The track capacity in this direction, however, being limited to three pairs of tracks, it is possible to give each of the smaller sub-divisions of the city only one line on each of these east and west streets supplemented by one or more lines running north and south across the district near the important points.

The greatest use of the east and west streets can be obtained by "Z" shaped through lines, the arms of which would run north and south with the connecting link occupying several blocks on an east and west delivery street. This would double the capacity of the delivery tracks ~~are~~ as compared with their use by L lines or east and west lines terminating at the Delaware River. An ideal system would comprise several such lines on each east and west street so spaced that a

prospective passenger on any street could take a car for any large section of the city. If three Z lines are located on each pair of east and west delivery tracks, they would cover practically all the north and south streets, and therefore could be spread over a wide territory.

The operation of the present north and south lines through the delivery district should be retained, but long lines which run to the north suburbs should be turned back at Locust Street. The connection of a long suburban with a short city line furnishes unsatisfactory service and schedules to both classes of patrons. Suburban lines are often equipped with large, high speed cars and should not be brought over long slow routes in the delivery district.

North and South Routes

The location of the original street railway lines under competitive conditions has resulted in an irregular arrangement of lines on the north and south streets. Cars run south on both 6th and 7th Streets, north on both 8th and 9th Streets, and north on both 18th and 19th Streets above Market. In the interest of uniformity of operation, and to make walking distances equal to reach the same delivery point this arrangement should be standardized so that lines would run in opposite directions on alternate streets. At the same time, north and south lines which straddle the territory between 4th and 8th Streets, 13th and 15th Streets and 12th and 16th Streets should be arranged to use adjacent streets. In the case of the 4th and 8th Street lines, passengers have a long walk one way to any delivery point, with the alternative of a ride around three sides of the lines which turn at Pine Street. The present 13th and 15th Street line is satisfactory, as there are no tracks on Broad Street, but the traffic on 12th and 16th Streets is so much out of balance that if enough cars are run on one street, there are too many on the other.

Routes in Residence Districts

Outside the delivery district there is hardly a section where there are not competitive parallel or interlacing lines. Often one of the competitive lines is located in narrow streets with frequent curves, this location having been necessary in order to invade the territory occupied by the original line.

Unprofitable Lines

While street railways should keep well abreast of the building up of city areas, there are several lines in Philadelphia which are not likely to be profitable for a number of years. Estimating the passenger miles per year on the basis of the September passenger count, the operating expenses for the fiscal year 1910 averaged one cent per passenger mile. The receipts per revenue passenger being 4.88¢, it will be seen that the Company lost money in operating expenses alone on all passengers hauled over 4.88 miles, without considering taxes, depreciation and interest on the investment. This statement, however, as to each individual line should be qualified by the factor of density of travel as shown by the average number of passengers on each car

of the line. The operating expenses per passenger mile on each line are thus determined by dividing the average operating expenses per car mile of the system by the average number of passengers at all times on each car of the line, this last factor being the passenger miles divided by the car miles.

By this calculation the following long lines or lines of light traffic show losses in operating expenses alone on all passengers carried for a greater distance than the proportion of length of the line shown by the percentage:

LINES WHERE RECEIPTS ARE LESS THAN OPERATING EXPENSES FOR PASSENGERS CARRIED FURTHER THAN CERTAIN PERCENTAGES OF LENGTH OF LINE

DISTANCE AT WHICH RECEIPTS EQUAL OPERATING EXPENSES

No.	Name	Per Cent Length of Line
Northeast		
78	Bridesburg	54%
71 N	Frankford 2 & 3	53
North		
56	Franklinville	62
36	Columbia	73
37	Fairmount	68
38	Manayunk	61
North Suburbs		
54 N	Fox Chase	60
64	Willow Grove, 13 & 15	62
58 N	Chestnut Hill	57
60	Pelham	55
49 N	Wayne	69
South		
5	Passyunk	59
West		
9	Chestnut	60
13	Baltimore	67
12	Darby	66
14	Gray's Ferry	56
16	Elmwood	55
18	Lancaster-Haddington	66
26	Belmont	57
27	Haddington-Hestonville	54
28	Overbrook	53
88	Lancaster-Haddington Subway	55
West (Continued)		
23	Haddington-Haverford	51%
24	63 & Vine	51
Crosstown West		
10	Chester Ave.	33
31	Zoo	18
22	Bala	74
South		
6	Point Breeze	62
7	Catharine & Bainbridge	59
North		
29	Race & Vine	41
40	Callowhill	39
42	Beach	59
20	Girard-Belmont	54
76	Girard	50
77	Jefferson	36
43	York & Dauphin	59
68	Lehigh	52
70	Erie	74
79	Allegheny	54
80	" Short Line	52
57	Olney	25
74	Frankford-Bridesburg	39
52	Glenside	54

The density of travel on the Willow Grove lines being much greater on Sundays than on the week days of the counts, the above statement is not fair to these lines. Considering the fixed charges on the property used, however, it is probable that the Company loses money on every passenger carried between the central portion of the city and Willow Grove Park.

Necessary New Track

There are some recently built-up localities, however, principally in West and South Philadelphia, where track additions are needed, as described under suggested routes.

General Principles of Rerouting

No matter how illogical or inconvenient a street car route may be as a whole, it is bound to suit the convenience of a certain number of people, so that however small a number this may be, any change will be opposed. After a term of years, a distinct traffic grows up along each line, and therefore, old established routes should not be changed without excellent reasons. Wherever changes are desirable, they should be made only if a large majority of patrons affected will have better facilities than they now enjoy.

In this consideration of the subject of routing, no attention has been paid to charter, lease or franchise limitations. It is assumed that the betterment of street car service for the people of Philadelphia will not be permitted to be restricted permanently by conditions of this nature.

The principal factors governing the location or alteration of street car routes are as follows:

1. History of present lines
2. Division of territory served, as between lines
3. Delivery
4. Directness
   (a.) Distance
   (b.) Curvature
5. Transfers required
6. Cost of ride
7. Balancing of ends and sides of double-end and parallel street lines
   (a.) Volume of Traffic
   (b.) Character of traffic
   (c.) Time of rush-hour peaks

History of Present Lines

A brief tabulated history of the present operated lines has been prepared to show what changes and additions have been made since the various traction consolidations and since electrical equipment. The present lines are grouped according to the traction company operating at the time of electrification. It will be noted that the Philadelphia Traction Company acquired 28 of the present lines and established 2. The Electric Traction Company acquired 12 lines and established 3. The People's Traction Company acquired 9 and established none. The Hestonville, Mantua & Fairmount Passenger Railway Company established 4 of the present lines and the Union Traction Company, which was the original general consolidation operating from 1895 to 1902, established 10 lines. The Philadelphia Rapid Transit Company, which has operated since 1902, has established 13 lines and acquired 7 suburban lines. The Philadelphia Rapid Transit Company also built and placed in operation the subway-elevated system on Market Street.

It will therefore be seen that of the present 89 lines, 53 were established by the horse car companies, and 31 have been established

since the original consolidation of the traction companies in 1895, principally in new territory.

Important Changes of Routes

Few important changes in route have been made in the original lines, although most of them have been extended. The important changes in the delivery district have been as follows:

RICHMOND 7 & 9	Routed through delivery district on 6th & 9th Streets
CAMBRIA 7 & 9	Changed from Market to Arch Street.
FAIRMOUNT	Turned east on Arch to Front in place of running across delivery district on 7th and 9th Streets.
HADDINGTON-LANCASTER	Changed from Chestnut and Walnut Streets to Market Street.
DARBY	Routed through the delivery district on Chestnut and Walnut Streets.
63 & VINE	Routed through the delivery district on Market Street.
RIDGE AVE.	Extended on Arch Street from 9th to Front.
CONTINENTAL-DEPOT CONTINENTAL-NICETOWN	Changed from Filbert & Sansom Streets to Arch and Walnut. (These lines have been changed since June 30, 1910, to Market Street, instead of Walnut.)
17 & 19	Extended on Chestnut & Walnut from 4th to Front.
PASSYUNK	Routed into the delivery district on 2nd and 3rd Streets to Dock.
BALTIMORE	Routed into the delivery district on Chestnut & Walnut Streets.
FOX CHASE	Routed through the delivery district on 5th & 6th Streets.
BERKS & MONTGOMERY	(Changed since June 30, 1910, to turn at Market Street instead of South Street.)
INDIANA	Routed across the delivery district on 4th & 8th Streets.
BELMONT	On Arch from Front to 7th & 9th Streets instead of from 2nd to 20th & 21st Streets.
HADDINGTON-HESTONVILLE	Routed into the delivery district on Arch Street, from 20th to Front Street.
MCKEAN 7 & 9	Turned west on Arch from 7th & 9th Streets to 20th & 23rd Streets.
17 & 18	Changed from Filbert and Walnut to Market Street and extending east to the ferries from 12th Street.
ELMWOOD	Routed across delivery district on 9th, Arch and 12th Streets.
LOMBARD & SOUTH	Discontinued on Front from Lombard to Dock Street.
CHESTER AVE.	Discontinued east of 40th Street, connecting with Market Street Elevated.

The principal changes outside of the delivery have been as follows:

RICHMOND 7 & 9	This was formerly a short line runing from Norris & Thompson Streets to 7th & Oxford Streets. It is now a diagonal line extending from north-east to south-west, crossing the delivery district on 6th & 9th Streets.

McKean 7 & 9	Northern end changed from Franklin & 7th and Columbia to Arch Street, 20th & 23rd Streets, Poplar Street, 29th Street, 31st & 32nd Streets to Strawberry Mansion.
Fairmount	Southern end on 7th & 9th Streets to Broad & Ellsworth discontinued.
Ridge	Turned from Ridge to 29th Street, thence north to Allegheny.
Baltimore	Baltimore Avenue was originally served by a loop line on Spruce, 38th, Lancaster Avenue and 40th Street with a terminus at 25th & South Streets. The present Baltimore Avenue line runs on Baltimore Avenue, 42nd Street, West Spruce Street, Woodland Avenue and east to Front Street via Chestnut and Walnut Streets.
Pelham	Discontinued from Pine to Snyder Avenue.

Important extensions have been:

Chestnut	West from 42nd & Chestnut to 65th & K ingsessing
Darby	East from 49th & Woodland to Front and Chestnut.
Lancaster-Haddington	West from Belmont & Girard to 63rd & Girard.
Gray's Ferry	West from Gray's Ferry Bridge to Darby.
Cumberland	South from Locust to Shunk.
13 & 15	South from Jackson to League Island.
Wayne	South from Locust to Jackson.
Morris & Tasker	North from Green & 23rd to Strawberry Mansion, by 29th Street and 31st & 32nd Streets.
Jefferson & Master	North from Hancock & Lehigh to Richmond & Allegheny.
Fairmount	North from Poplar to York, by 29th Street and 31st & 32nd Streets.
Continental-Depot	West on York & Dauphin from 22nd to 32nd Street.
Continental-Nicetown	North from Susquehanna to Hunting Park.
17 & 19	North from Norris to Hunting Park Avenue.
Fox Chase	North from Rising Sun Lane to Fox Chase, South to Porter.
Lehigh Avenue	West from Broad to Ridge.
Haddington-Hestonville	West from 52nd & Lancaster to 63rd & Girard. East from 43rd & Lancaster to Front & Arch.
Norris & Susquehanna	West on York & Dauphin from 22nd to 32nd Streets.
Franklinville	North from Rising Sun Lane to Olney.
Indiana	South from Dauphin to Ritner. North from Indiana to Rising Sun Lane.
Girard	North from Gunners Run to Allegheny. West from 54th to 63rd Street.
Bala	South from Jefferson to Market.
58 & 60	North from 60th & Master to 63rd & Lansdowne.
Elmwood	East from Paschall to 9th & Arch, via Gray's Ferry, Spruce & Pine and 9th & 12th Streets.
Lancaster-Haddington Subway	West from 44th & Girard to 63rd & Girard.
Chester	Folsom to Darby.
Media	Swarthmore to Media.
Middletown	Wells Corner to Media.

Division of Territory

Territory of a homogeneous residential character should be provided with street railway lines and service approximately according to its density of population. Lines to the same objectives should be spaced as uniformly as possible and should not interlace. Lines running in the direction of heaviest travel should be closer together than crosstown lines as the average walk should be shortened as much as possible for the greater number of passengers. In a series of "L" shaped lines those adjacent on one leg of the L should be spread as much as possible on the other. Crosstown lines are generally required at intervals to supplement the partial crosstown service furnished by "L" lines, and it is generally possible to route crosstown lines to secondary traffic or delivery districts. In residence districts, it is better to have few lines with frequent service than to have numerous lines with long headways; for although the average walk may be somewhat longer, the total time for the journey will be less.

Delivery

As so large a proportion of the travel is to and from points in the main business or delivery district, it is important that all sections of the city should have good and as nearly as possible equal facilities for reaching all parts of this district without transfer. Long lines or interurbans need only touch the district but short lines should have the best delivery routes to attract the short distance riders. Secondary delivery districts occur at retail centers outside the main shopping district, at large industrial works, schools, groups of factories, important railroad stations and parks. Such districts generally require some radiating lines and interconnection. In the case of parks and amusement resorts, it is sometimes better to provide special routes to be operated during the summer season, than to operate fixed lines from morning to night every day in the year.

Directness

After the objectives are determined upon, the main requisite of a route is that it shall be direct. The more direct the route the shorter the time required for the journey, which should mean an advantage both to the passenger and the Company. If the one and one-quarter million daily street car rides in Philadelphia could each be shortened by one minute, the cash saving at 15 cents per hour would amount to nearly $1,000,000 per year. The saving of ten minutes per day, five minutes in each direction, would be equivalent to a gain to the traveller of six working days in one year. To this end, the route between objectives should be the shortest practicable, and the curvature should be reduced to a minimum. Doubling back of a line on itself should be avoided. In this connection, it should be remembered that the rate of speed in the delivery district is much slower than the average, so that the best delivery is often at the expense of speed.

Transfers

In general, a passenger should be able to travel from any part of a city to any other, without change of cars. It is not entirely practicable, however, to provide for this, and a passenger from one dis-

trict of the city to another outside the main delivery district can often reach his destination more quickly by the use of a transfer. Transferring is objectionable to the passenger, as it requires changing cars and waiting for connections. It is also objectionable to the company on account of the increase of rides to unprofitable lengths and the difficulty of restraining abuses. Therefore, it is desirable to provide routes which avoid as far as possible the necessity of transfer. Too much attention to this consideration, however, may result in unnecessary duplication of car mileage. In order to avoid congestion of traffic and car service, and the abuse of the privilege, transfers should be avoided in the delivery district.

Double End Lines

By connecting lines which run into the delivery district from opposite sides, the patrons on each end are afforded a greater range of rides without transfer, duplication of car mileage in the delivery district is avoided, and the capacity of the delivery district trackage increased. Such connections are therefore desirable from all points of view. The ends of the line should be balanced as to length, volume of traffic, character of traffic and time of peak loads. If the volume of traffic on each end is not the same at each hour, the service will be unequal. If the character of traffic is not the same, travel between the districts connected will be discouraged. On each leg of the line occupying parallel streets the traffic should balance in volume and character. An example of this in Philadelphia is the large difference in volume of traffic on 12th and 16th Streets.

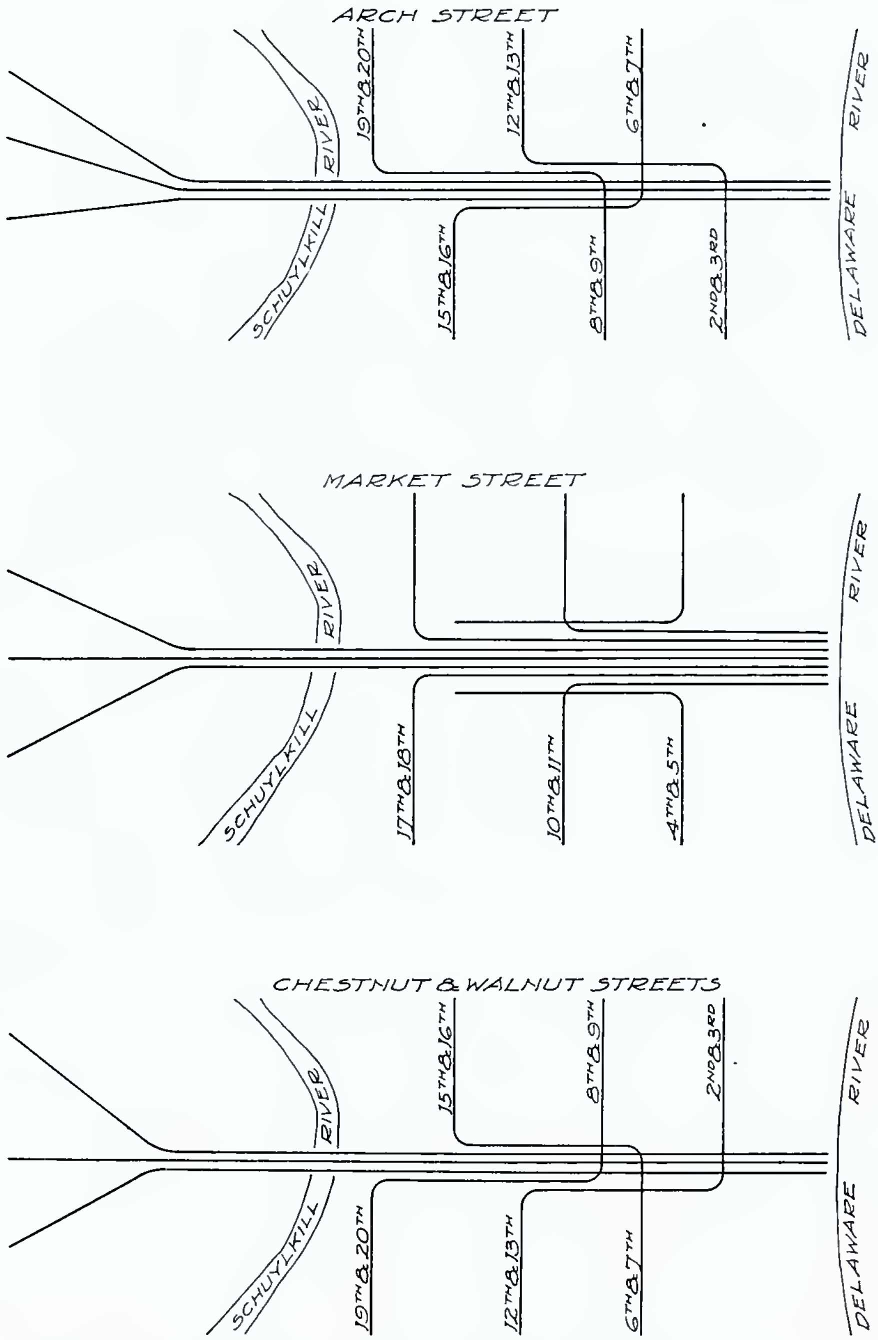
General Rerouting Plan

It is desirable that a definite plan of rerouting as nearly perfect as practicable be worked out for Philadelphia and agreed to by all parties interested, and that upon such a plan all future extensions and alterations should be based. It is not necessary that the entire plan should be put into effect at once. As an approach to the subject and as an example of what might be done, a tentative routing system or study has been prepared in connection with this report. This plan embodies in general the principles which have been discussed and is based to a considerable extent upon the information obtained for this report by passenger counts and assortment of transfers and exchanges. The subject, however, is so large and of such vital importance to all, that careful study and consideration should be given by all interests involved, and a final plan prepared, agreed to and carried out.

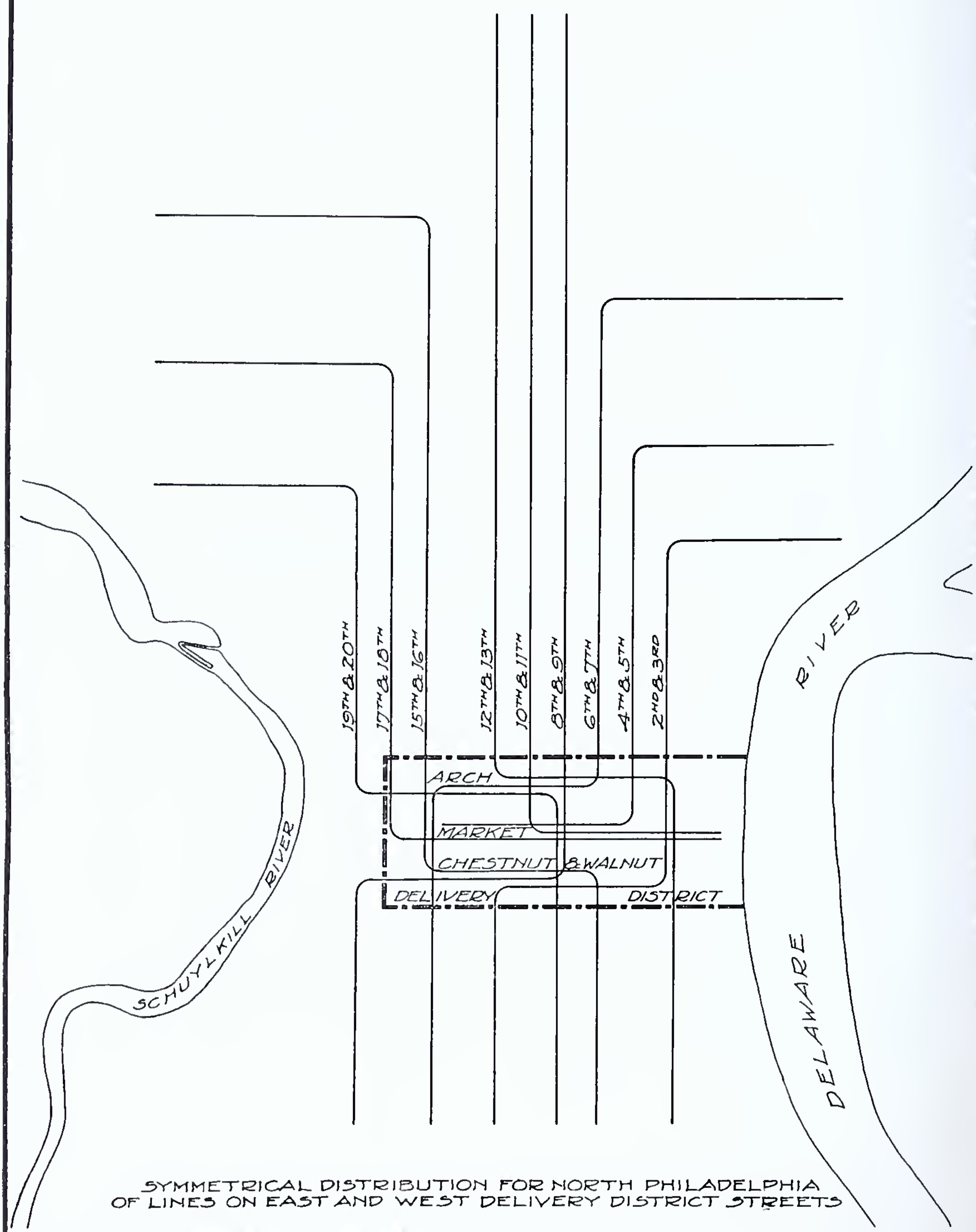
"Z" Lines

The first step of the rerouting plan was to design a system of "Z" shaped lines which would utilize the east and west tracks in the delivery district most efficiently and uniformly and would furnish interconnection between diagonally opposite districts of the city. Such a system is shown on Diagram No. 1 for Arch Street and for Chestnut and Walnut Streets. On account of the business to the ferries, a system of "L" shaped lines is shown for Market Street, the north and south lines from

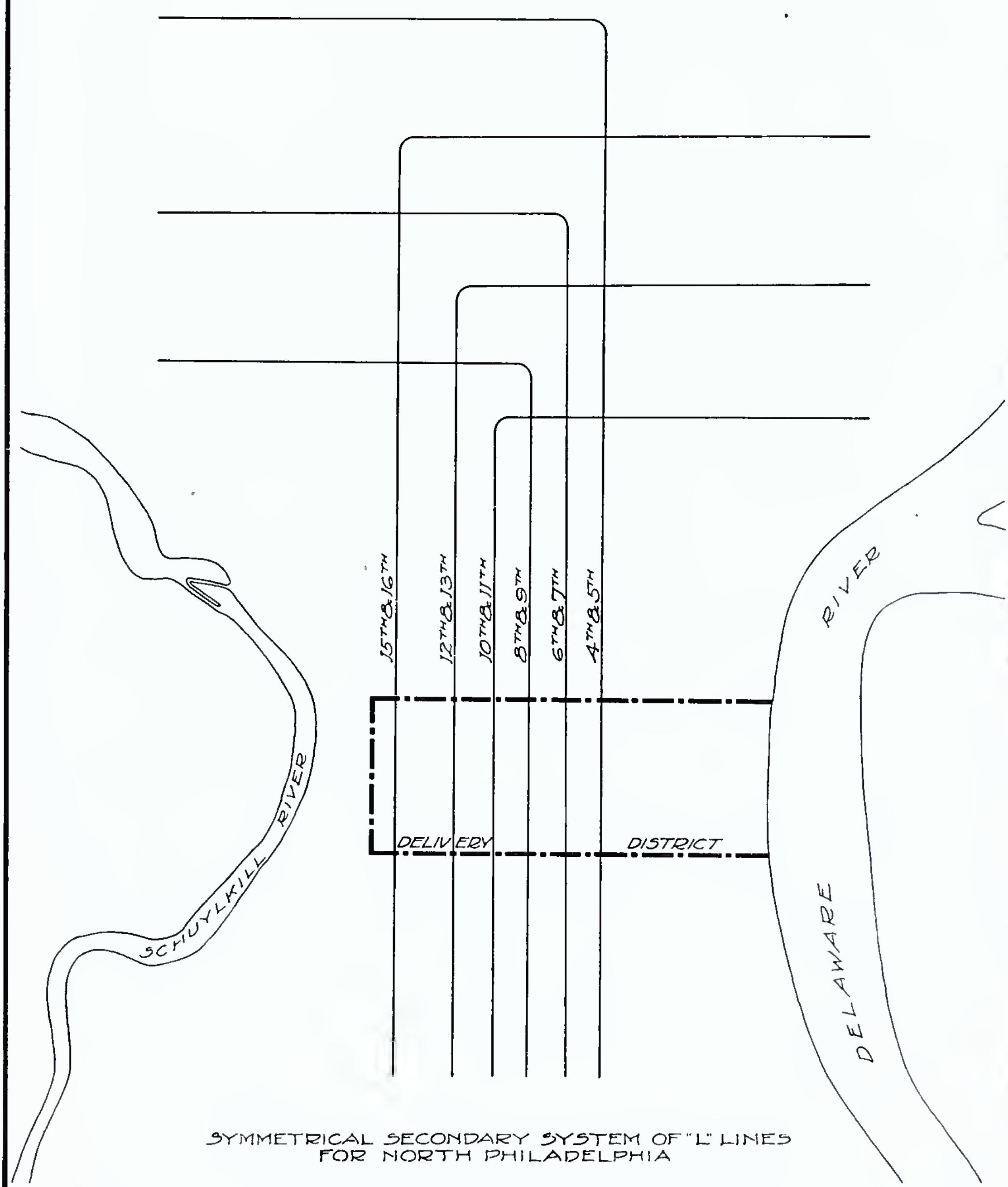
1



SYMMETRICAL ARRANGEMENT OF LINES
ON EAST AND WEST DELIVERY DISTRICT STREETS

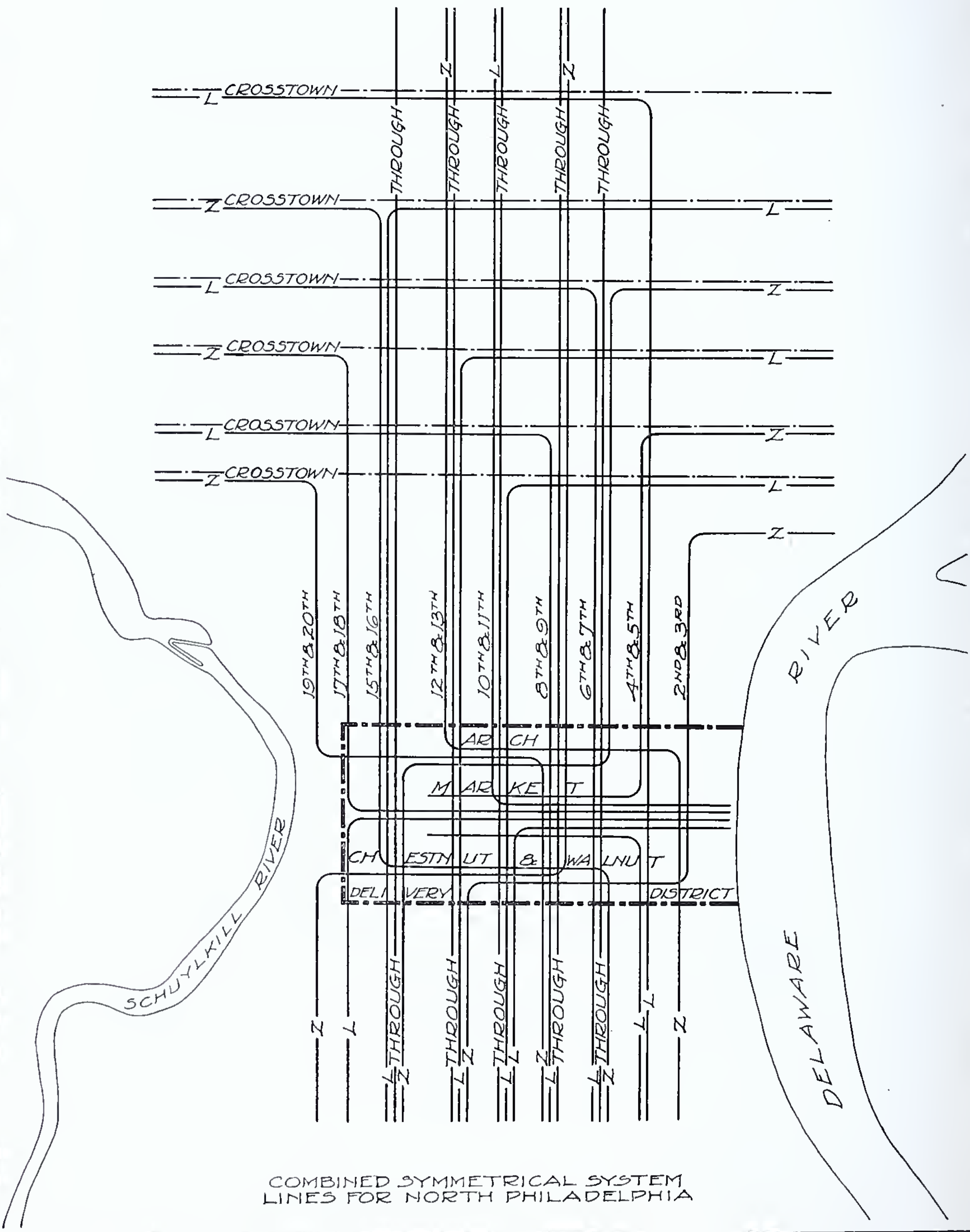


SYMMETRICAL DISTRIBUTION FOR NORTH PHILADELPHIA
OF LINES ON EAST AND WEST DELIVERY DISTRICT STREETS



SYMMETRICAL SECONDARY SYSTEM OF "L" LINES
FOR NORTH PHILADELPHIA

4



COMBINED SYMMETRICAL SYSTEM
LINES FOR NORTH PHILADELPHIA

10th and 11th Streets and from 17th and 18th Streets turning east to the ferries, and those from 4th and 5th Streets turning west to City Hall. From each pair of east and west delivery tracks a set of three diverging lines extends to West Philadelphia.

The next step is to spread the north and south arms of these lines to cover symmetrically the settled territory north of Market Street where the city broadens to east and west. To embrace this territory, therefore, the arms projecting north must be spread laterally or turned at right angles. The latter device is preferable to avoid curvature and to supplement the crosstown service, and this is shown on Diagram No. 2.

"L" Lines

The east and west branches thus located are so far apart that it is necessary to provide lines between. This leads to a system of "L" shaped lines, those coming from the west extending as far east as possible before turning south, and those coming from the east as far west as possible. This gives a passenger from the northwest, for example, the choice of a Z line running south through the district west of Broad Street and thence easterly through the delivery district or of an L line running south through the district east of Broad Street and directly across the delivery district. The system of L lines by itself is shown on Diagram No. 3.

The two systems of lines shown separately on Diagrams Nos. 2 and 3 are combined in Diagram No. 4.

North and South Lines

The passenger count shows that about 37,000 passengers per day are carried each way north and south through the delivery district to districts beyond. Through north and south lines should therefore be added on each pair of streets east of 17th St.

The classification of transfers showed 2,724 passengers per day transferring across Market Street on 17th, 18th, 19th and 20th Streets. This business is hardly large enough to warrant through lines at present.

Crosstown Lines

In usual residence districts crosstown lines would be necessary only along alternate arms of such a system as shown on Diagram No. 4. In the northern part of Philadelphia, however, there are important secondary traffic centers which support crosstown lines at more frequent spacing. On the combined diagram, therefore, crosstown lines have been shown along every east and west arm.

Application of Symmetrical Plan

In the practical application of such a system it is necessary to vary somewhat from fixed rules and symmetrical location in order to allow for existing lines of travel, for special needs of certain sections or secondary delivery districts and for preference in physical character of streets.

Dissected Routing Diagrams

In the study of existing and suggested routes, the various lines and groups of lines of the system have been dissected and shown by maps or diagrams which are included in Volume II. The lines in each general section of the city leading to the delivery district are shown by themselves and the crosstown lines are likewise separated. Diagrams have also been prepared showing all lines using each of the east and west delivery district streets. These diagrams show clearly the defect in the present routing system of not serving impartially the entire city. In the suggested system a special effort has been made to give a wide range of destination to the lines on each group of parallel streets, and large transfer movements have been eliminated.

Routes in Outlying Districts

In this study, little time has been given to the consideration of routes in the outlying districts, as the important problem in Philadelphia is in the built-up portions of the city, where many lines converge and where a wide range of destination from each street is required. In outlying sections, however, it is important that lines should be located so that they will be economical when the territory becomes thickly settled. As is the case in steam railroad economics, every unnecessary foot of track, and every unnecessary foot of rise and fall or degree of curvature, imposes a burden on operation, which is very expensive in a long term of years. In the location of tracks on right of way or along country roads, ample width should be secured while the territory is open. There are several points on the present lines where wider right of way should be secured, the streets widened and where the alignment should be corrected while it can be done cheaply. Points of this description are found on the Island Road, Point Breeze and Passyunk Avenue lines.

Numbering and Grouping of Lines

To simplify identification the 89 lines operated on June 30, 1910, have been numbered in the order of arrangement used by the Company. The so-called double end lines which run through the delivery district from North to South Philadelphia have been treated in many of the calculations as separate lines divided at Market Street, with the number of cars in use divided according to the schedule time on each side of Market Street. Where so divided the suffixes "N" for the northern end and "S" for the southern end are used with the number.

On the diagrams showing the suggested routes, lines corresponding with present lines are given the same numbers with 100 added.

Conventional Sections

The city has been divided into conventional sections about three-quarters of a mile long by one-half mile wide, being in general smaller near the delivery district and larger toward the outskirts. There are about 100 such sections, and these in turn are grouped in districts, each district comprising 2, 3, or 4 sections. The delivery district is divided into three sections by north and south lines between 5th and

6th Streets and between 11th and 12th Streets. In some calculations, the business at the ferries and at Front Street has been treated as if in a separate section. For the composite day of the riding count, the number of passengers on and off in each section and their origin and probable destination have been computed.

Delivery District Connections

It is considered that a passenger from each of these sections should be able to reach any delivery district section without change of cars. Under the present system, connections are lacking between sections as follows:

NUMBER OF SECTIONS HAVING NO DIRECT CONNECTION WITH DELIVERY DISTRICT SECTIONS

Sections in the	Total Number of Sections	D 1 Delaware River Ferries	D 2 Front to 5th Streets Inclusive	D 3 6th to 11th Streets Inclusive	D 4 12th to 17th Streets Inclusive	Total
Northeast	13	0	0	5	12	17
North Suburbs	11	3	0	2	3	8
North Philadelphia	32	2	2	5	14	23
South Philadelphia	17	5	5	7	5	22
West Philadelphia	27	1	1	1	1	4
Total	100	11	8	20	35	74

North and South Streets to be Operated in Pairs

For reasons before stated, it is suggested that the north and south streets be operated in pairs, cars running north on odd numbered streets east of Broad Street and on even numbered streets west of Broad as far as 20th St., and south on adjacent streets. This rule would result in changing the direction on 7th and 8th Streets, both north and south of Market St. and on 18th and 19th Sts. north of Market St. Lines are thus located in pairs on 2nd and 3rd Sts., 4th and 5th Sts., 6th and 7th Sts., 8th and 9th Sts., 10th and 11th Sts., 12th and 13th Sts., 15th and 16th Sts., 17th and 18th Sts. and 19th and 20th Sts. The Ridge Avenue lines which are naturally routed on 9th and 10th Sts., disturb the above relation, and it is also desirable to continue the Wayne Ave. line on 13th and 15th Sts. To balance these lines, therefore, one line is located on 11th and 12th Sts., and one on 7th and 8th Sts.

On nearly all of the paired streets at present cars are operated left handed. This results in many extra crossings at points where it is necessary to change to the right hand track as on double track streets. At the intersection of narrow streets, however, it is possible to obtain easier curves when the tracks are so arranged and on this account the present system is retained. Because of the narrow streets it is considered that crossings are preferable to curves in Philadelphia.

Description of Route Maps

One set of route maps or diagrams of Volume II shows routes existing June 30, 1910, and another shows the routes suggested. A brief description of each group of lines is given herewith, covering principally general range of destination and delivery. The principal changes suggested are also described.

Lines between Northeast Philadelphia and the Delivery District

At present there are 7 lines leading from the Northeast to the delivery district, as follows: (See Map No. 4.)

EXISTING LINES

Number	Name	Number	Name
78	Bridesburg	73	Frankford Lehigh 5 & 6
69	Tioga & Dock	71	Frankford 2 & 3
67	Berks & Montgomery	4	Richmond 7 & 9
72	Frankford Berks 5 & 6		

The first three of these lines turn back at the delivery district; the three Frankford lines continue south to the easterly part of South Philadelphia and the last continues to the southwest. Five lines pass through the delivery district east of 7th Street; one enters on 10th and 11th Streets, and one runs north on 9th Street and south on 6th Street.

It is suggested that this district be served by the following 8 lines: (See Map No. 6.)

SUGGESTED LINES

Number	Name	Number	Name
178	Bridesburg	173	Kensington 12 & 13
169	Front-S. 12 & 13	171	Frankford-Market
167	Kensington 8 & 9	104	Richmond-S. 15 & 16
172	Kensington 4 & 5	120	Richmond-League Island

Under this plan three lines turn back at the delivery district, two continue to the south central section, one extending to League Island, one to the southwest, and one continues to the southeast. Two lines run east and west through the delivery district, three enter east of 6th Street and four west of 8th Street.

Changes in individual lines and the reasons therefor are as follows:

The Bridesburg line is run on Girard Avenue in both directions from Norris Street to 2nd and 3rd Streets. The ride from the principal centers of population along this line to the delivery district is long, and it is therefore desirable that the route should be as direct as possible. (No. 178).

A line corresponding with the present Tioga and Dock, is run in both directions on Front Street on double track from Erie to Girard Avenue, thence westerly to 2nd and 3rd Streets, thence southerly to Race and Vine, thence westerly to 8th and 9th Streets, thence southerly to Spruce and Pine Streets, thence westerly to 12th and 13th Streets, thence southerly to Shunk Street. (No. 169).

The three lines on Kensington Avenue after turning south are spread apart to cover uniformly the entire district east of Broad Street and south of Lehigh Avenue, entering the delivery district on 4th and 5th Streets (No. 172), 8th and 9th Streets (No. 167) and 12th and 13th Streets (No. 173) respectively. The line corresponding with the present Berks and Montgomery (No. 67) and the line on 4th and 5th Streets are carried south to Porter. The line on 12th and 13th Streets is turned at Locust.

The line on Frankford Avenue is materially altered, both tracks being carried south on Frankford to Jefferson and Master Streets, thence west to 4th and 5th Streets, thence south to Market Street and west on Market to City Hall. This change gives Frankford Avenue a route through nearly the entire length of the delivery district. The present line running through to Ritner is

unbalanced north and south of Market Street as to distance and traffic. (No. 171).

The Richmond 7th and 9th Streets line is altered to run on Richmond and Girard instead of Thompson and Girard, and to serve the territory now covered by the Bridesburg line between Girard Avenue and Green Street. Thompson Street is narrow and with a double track line on Frankford Avenue, passengers between Frankford and Girard will have a maximum walk of not over 1,000 feet. Between Girard Avenue and Green Street the street layout is such that many curves are necessary. The suggested route (No. 104), however, has less curvature than the present route, and because the line is shorter, the curvature is not so objectionable as on the Bridesburg line. This route continues westerly on Green and Fairmount to 5th and 6th Streets, thence southerly to Arch Street, thence westerly to 15th and 16th Streets, thence southerly to Ellsworth and Wharton, thence westerly to 22nd and 23rd Streets, and southerly to its present terminus. These changes give passengers on both ends of this line a route east and west through one-half the delivery district, passing the Reading Terminal and the Broad Street Station. Whenever a street is carried under the Richmond Branch of the Philadelphia & Reading Railway tracks east of Lehigh Avenue, this line should be extended northeasterly along Aramingo Avenue.

In order to give people on Richmond Street access without change to the central part of the delivery district, a new line is located on Richmond from Allegheny to Norris, to Girard Avenue, to 10th and 11th Streets, thence south to Porter, thence west to Broad Street and south to League Island. (No. 120).

Lines between North Philadelphia—Broad to Front Streets and the Delivery District

At present there are 22 lines between North Philadelphia—Broad to Front Streets, and the delivery district, as follows: (See Map No. 5).

EXISTING LINES

On 2nd & 3rd Streets:

Number	Name
69	Tioga & Dock
71	Frankford 2 & 3
78	Bridesburg

On 4th & 8th Streets:

Number	Name
34	Norris & Susquehanna
53	Indiana
58	Chestnut Hill (including 59)
60	Pelham
63	Willow Grove 4 & 8

On 5th & 6th Streets:

Number	Name
54	Fox Chase (including 55)
56	Franklinville
72	Frankford Berks 5 & 6
73	Frankford Lehigh 5 & 6

On 7th & 9th Streets:

Number	Name
33	Cambria 7 & 9
36	Columbia

On 6th & 9th Streets:

Number	Name
4	Richmond 7 & 9

On 10th & 11th Streets:

Number	Name
32	10 & 11
67	Berks & Montgomery

On 12th Street Southbound:

Number	Name
1	12 & 16

On 13th Street Northbound:

Number	Name
47	Cumberland
48	13 & 15
49	Wayne
64	Willow Grove 13 & 15

Ten of these lines turn back at the delivery district; six continue to the southeast; five to the south central, and one to the southwest. Two lines run east and west through the delivery district east of 9th Street; thirteen others enter east and seven west of 9th Street.

It is suggested that this district be served by the following 22 lines: (See Map No. 6).

SUGGESTED LINES

On 2d & 3d Streets:

Number	Name
193	2 & 3-Snyder Avenue
178	Bridesburg
169	Tioga & Dock

On 4th & 5th Streets:

Number	Name
171	Frankford-Market
158	Chestnut Hill
172	Kensington Ave.-4 & 5
153	4 & 5
156	Franklinville

On 5th & 6th Streets:

Number	Name
154	Fox Chase

On 6th & 7th Streets:

Number	Name
104	Richmond-S. 15 & 16
134	Norris & Susquehanna
163	Willow Grove-6 & 7

On 8th & 9th Streets:

Number	Name
102	S. 19 & 20-No. 7 & 8
167	Kensington-8 & 9

On 10th & 11th Streets:

Number	Name
120	Richmond-League Island
132	10 & 11
160	Pelham
136	Columbia

On 12th & 13th Streets:

Number	Name
173	Kensington-12 & 13
164	Willow Grove-12 & 13
147	12 & 13

On 13th Street Northbound:

Number	Name
149	Wayne

Twelve of these suggested lines turn back at the delivery district; three continue to the southeast; five continue to the south central, and two to the southwest. Four lines run east and west through the delivery district; nine others enter east of 7th Street and nine west of 7th Street.

Changes in individual lines not elsewhere described and the reasons therefor, are as follows:

A double track line (No. 193) is located on 2nd Street from Erie to Jefferson, running thence south on 2nd and 3rd Streets to Snyder Avenue, thence west to 23rd Street. With double tracks thus on both Front and 2nd Streets, the tracks on Hancock and Howard Streets would be removed. It is less than one-quarter mile from Front to 2nd Streets, and with double track lines on these two streets this territory would be much better served than at present.

A line corresponding with the present Indiana is shown on 4th and 5th Streets from Rising Sun Avenue to Porter Street, (No. 153).

A line corresponding with the present Norris and Susquehanna is run south on 6th Street to Porter, thence north on 7th Street to Pine Street, to 9th to Spring Garden to Franklin to Susquehanna. (No. 134). It is necessary to divert this line to 9th to avoid running against the Walnut Street traffic at Washington Square. This diversion could be eliminated if 7th Street were cut through from Walnut to Sansom Streets on the north line of the Square.

The line on 7th and 8th Streets (No. 102), corresponding to the present Cambria, 7 and 9, running west to the North Phila-

delphia Station at the northern end without the numerous turns of the present line. At Spring Garden Street the track on 7th Street is stepped over to 9th Street and the line thence runs on 8th and 9th Streets to Chestnut and Walnut Streets, where it turns west and connects with the present South 19th and 20th Streets line, forming a Z line from central north to southwest.

The Columbia Avenue line (No. 136), is located on 10th and 11th Streets where it has recently been running temporarily. This avoids the present offset at Spring Garden Street, and affords better delivery by entering Market Street two blocks west of the present route.

A north and south line (No. 147), is shown on 12th and 13th Streets running from Erie Avenue to Shunk Street.

The present 10th and 11th Streets line is unchanged (No. 132).

Lines between North Philadelphia—Broad Street to Schuylkill River and the Delivery District

At present there are 17 lines leading from the Northwest to the delivery district, as follows: (See Map No. 7).

EXISTING LINES

Number	Name	Number	Name
34	Norris & Susquehanna	45	Continental Depot
36	Columbia	46	Continental Nicetown
1	12 & 16	38	Manayunk
47	Cumberland	44	Ridge
48	13 & 15	35	McKean
49	Wayne	37	Fairmount
64	Willow Grove 13 & 15	41	Dickinson
50	17 & 19	39	Morris & Tasker (not entering delivery district proper)
51	17 & 19 Short Line		

Ten of these lines turn back at the delivery district, two continue to the southeast and four to the south central, one of which extends to League Island. Another line, Morris & Tasker (No. 39), runs south on 22nd and 23rd Streets to the southwest and thence crosstown to the southeast. Seven lines run east and west in the delivery district, three others enter east of 10th Street and four west of 10th Street.

It is suggested that this district be served by the following fourteen lines: (See Map No. 8).

SUGGESTED LINES

Number	Name	Number	Name
134	Norris & Susquehanna	144	Ridge
136	Columbia	135	Strawberry Mansion-So. 8 & 9 (McKean)
149	Wayne	129	Poplar-So. 2 & 3
145	No. 15 & 16-So. 6 & 7	141	West Girard, 12 & 13 (Dickinson)
101	15 & 16	139	Morris & Tasker (not entering delivery district proper)
146	Nicetown 17 & 18		
150	No. 17 & 18		
151	No. 19 & 20		
138	Manayunk		

Six of these lines turn back at the delivery district, four continue to the southeast and three to the south central. The Morris & Tasker line is unchanged on the southern end. Four lines are run east and

west through the delivery district, six others enter east of 10th Street, and three west of 10th Street.

Changes in individual lines not elsewhere described and the reasons therefor, are as follows:

A north and south line (No. 101), is shown on 15th and 16th Streets from Erie Avenue to Shunk Street.

York and Dauphin Streets west of 16th are served by turning one of the 15th and 16th Streets lines west to 25th and 26th Streets (No. 145). If turned north ultimately on 25th and 26th Streets this would divide the territory between 22nd and 29th Streets. York and Dauphin Streets west of 27th Street are served by the line on 29th Street. The crosstown and park business on Norris and Susquehanna and York and Dauphin Streets would be served by the present crosstown York and Dauphin lines, which, if located on Dauphin and Susquehanna east of 22nd Street would divide the territory between Lehigh and Columbia Avenues more evenly than at present. The proposed 15th and 16th Streets line with the above branch is turned east on Chestnut and Walnut Streets and south on 6th and 7th Streets, forming a Z line from northwest to southeast.

A line corresponding with the present Continental-Nicetown is shown on 17th and 18th Streets instead of 18th and 20th, with delivery on Arch Street (No. 146). With the suggested arrangement of lines on North 17th, 18th, 19th and 20th Streets there would be one line having delivery on Chestnut and Walnut Streets, one on Market Street and two on Arch Street.

The Franklinville line is turned east on Chestnut and Walnut Streets to Front Street, to give people along 4th and 5th Streets a direct line to the ferries.

A line corresponding with the present No. 17th and 19th Streets line runs on 17th and 18th Streets, turning east on Market Street and connecting with So. 4th and 5th Streets. (No. 150).

A line corresponding with the present No. 17th and 19th Streets Short Line runs on 19th and 20th Streets, turning east on Chestnut and Walnut Streets to 8th Street. (No. 151).

The Manayunk line is unchanged. (No. 138).

The Ridge Avenue line (No. 144), is carried south on 9th and 10th to Locust, instead of east on Arch to Front Street.

The Norris and Susquehanna line (No. 134), terminates at 22nd Street instead of continuing west on York and Dauphin.

The northern end of the McKean, 7th and 9th Streets line is altered to run on Jefferson and Master Streets, from 29th to 19th and 20th Streets, thence south to Arch Street, thence east to 8th and 9th Streets, thence south to Porter (No. 135). This makes a straighter route than at present and serves the territory north of Girard College, which is now cut off.

The territory between 19th and 20th Streets and the Schuylkill River south of Girard Avenue through which the McKean 7 & 9 line winds at present, would be served by a modification of the present Dickinson line and by a new line taking the place of the present Race and Vine Streets line, and also partly of the present Fairmount line, running from the Poplar Street loop to 22nd and 23rd Streets, to Race and Vine Streets, to 2nd and 3rd Streets, and thence south to Porter (No. 129). The service on

South 2nd and 3rd Streets would be divided between this line and the new north and south line.

The suggested line to replace the northern end of the present Dickinson line runs on 12th and 13th Streets from Shunk to Fairmount and Green Streets, thence west to 25th and 26th thence north to Girard and thence over the Girard Avenue bridge to 44th and Elm. (No. 141). This line, together. with the suggested line on East Girard Avenue and Richmond Street might replace the present Girard-Belmont line except in the park season.

The route of the Morris and Tasker line (No. 139), is straightened north of Arch Street.

Lines between North Suburbs and the Delivery District

At present there are 7 lines leading from the North Suburbs to the delivery district, as follows: (See Map No. 9).

EXISTING LINES

Number	Name	Number	Name
54	Fox Chase (including Fox Chase & Powell 55)	60	Pelham
56	Franklinville	63	Willow Grove 4 & 8
58	Chestnut Hill (including Chestnut Hill 2nd Section 59)	64	Willow Grove 13 & 15
		49	Wayne

The following lines shown on Map No. 9 do not enter the Delivery District:

Number	Name	Number	Name
61	Chelten	75	Torresdale
57	Olney	74	Frankford-Bridesburg

Four of the delivery district lines turn back at the delivery district, while three continue south into South Philadelphia. Five lines enter the delivery district east of 9th Street, and two west of 9th Street.

It is suggested that this district be served by the following 7 lines: (See Map No. 10).

SUGGESTED LINES

Number	Name	Number	Name
154	Fox Chase	160	Pelham
156	Franklinville	164	Willow Grove 12 & 13
163	Willow Grove 6 & 7	149	Wayne
158	Chestnut Hill		

The following lines shown on Map No. 10 do not enter the delivery district:

Number	Name	Number	Name
197	Wayne-Somerset-Lehigh	174	Frankford-Bridesburg
157	Olney	175	Torresdale
161	Chelten	152	Glenside

All of these delivery district lines are turned back at the delivery district. Four enter the delivery district east of 9th Street and three west of 9th Street.

Suggested changes in individual lines are as follows:

The Wayne Avenue line is routed on 13th and 15th Streets.

The two Willow Grove lines are routed on 12th and 13th Streets, and 6th and 7th Streets.

The two Germantown Avenue lines are routed on 10th & 11th Streets and 4th & 5th Streets.

The Fox Chase line is routed on 5th & 6th Streets to Spring Garden, and thence into the delivery district by 7th & 8th Streets.

Lines between South Philadelphia and the Delivery District

At present there are 18 lines leading from South Philadelphia to the delivery district as follows: (See Map No. 13).

EXISTING LINES

2d & 3d Streets:

Number	Name
71	Frankford-2 & 3

4th & 8th Streets:

Number	Name
41	Dickinson
53	Indiana
58	Chestnut Hill

5th & 6th Streets:

Number	Name
54	Fox Chase
72	Frankford Berks 5 & 6
73	Frankford Lehigh 5 & 6

6th & 9th Streets:

Number	Name
4	Richmond-7 & 9

7th & 9th Streets:

Number	Name
35	McKean

10th & 11th Streets:

Number	Name
32	10 & 11

12th & 16th Streets:

Number	Name
1	12 & 16

13th & 15th Streets:

Number	Name
47	Cumberland
48	13 & 15
49	Wayne

17th & 18th Streets:

Number	Name
3	17 & 18

19th & 20th Streets:

Number	Name
2	19 & 20

22nd & 23d Streets:

Number	Name
39	Morris & Tasker (not entering the delivery district proper)

Passyunk Ave.:

Number	Name
5	Passyunk

Of the 10 lines east of 12th Street three extend to the extreme northeast; two to the north suburbs; two run due north into North Philadelphia, and two to the northwest. One line only runs east and west in the delivery district.

Of the 6 lines west of 11th Street, two run through the entire length of delivery district; one extends to Germantown, and three run due north into North Philadelphia. One line originates in the southwest, runs crosstown to 6th & 9th Streets, and thence to the northeast. One originates in the southeast, runs crosstown to 22nd & 23rd Streets, and thence to the northwest. One line originates in the extreme southwest and runs diagonally northeast to the vicinity of the Delaware River ferries.

It is suggested that this district be served by the following 21 lines: (See Map No. 14).

SUGGESTED LINES

2d & 3d Streets:

Number	Name
129	Poplar-S. 2 & 3
193	2 & 3-Snyder Ave.

4th & 5th Streets:

Number	Name
150	N. 17 & 18
153	4 & 5
172	Kensington-4 & 5

6th & 7th Streets:

Number	Name
134	Norris & Susquehanna
145	N. 15 & 16-S. 6 & 7

8th & 9th Streets:

Number	Name
135	Strawberry Mansion-S. 8 & 9
167	Kensington-8 & 9

SUGGESTED LINES (Continued)

10th & 11th Streets:

Number	Name
120	Richmond-League Island
132	10 & 11
191	10 & 11-Market

12th & 13th Streets:

Number	Name
141	West Girard-12 & 13
147	12 & 13
169	Front-S. 12 & 13

15th & 16th Streets:

Number	Name
104	Richmond-S. 15 & 16
101	15 & 16

17th & 18th Streets:

Number	Name
103	17 & 18

19th & 20th Streets:

Number	Name
102	S. 19 & 20-N. 6 & 7

22d & 23d Streets:

Number	Name
139	Morris & Tasker (not entering the delivery district proper)

Passyunk Avenue:

Number	Name
105	Passyunk

Of the 12 suggested lines east of 10th Street three extend to the northeast, one continuing to Frankford; three run due north into North Philadelphia; five run to the northwest and one runs to the foot of Market Street. Four of these lines run east and west through the delivery district.

Of the 7 lines west of 11th Street two run to the northeast; two run due north into North Philadelphia; one runs to the northwest and across the Girard Avenue bridge into West Philadelphia; and one runs to the foot of Market Street. Three of these lines run east and west through the delivery district.

In addition to the above lines are the Passyunk and Morris & Tasker lines, which are practically unchanged in South Philadelphia.

Changes in individual lines not elsewhere described and the reasons therefor are as follows:

The lines between South Philadelphia and the delivery district are nearly all double end lines running through to the north and therefore have been described above. Other lines serving this section are the present 17th and 18th Streets line (No. 103), which is shown unchanged, and a new line on 10th and 11th Streets running to the Market Street ferries (No. 191).

The north and south line on 2nd and 3rd Streets (No. 193), is shown turning west on Snyder Avenue to 24th Street. This will furnish a much needed crosstown line south of Morris and Tasker Streets, connecting with the continuous line of industrial establishments between 2nd Street and the Delaware River.

The League Island line (No. 120), is located on 10th and 11th Streets, instead of 13th and 15th Streets, and is connected with the suggested line on Girard Avenue and Richmond Street.

The Passyunk Avenue line (No. 105), is carried north to Race Street in place of turning at Dock Street.

While none of the lines from the north suburbs are run south of the delivery district, the suggested lines in South Philadelphia give a much wider range of destination in North Philadelphia than at present.

West Philadelphia—Market Street, North

At present there are 9 lines leading from West Philadelphia—Market Street North, to the delivery district, as follows: (See Map No. 17)

EXISTING LINES

Number	Name	Number	Name
24	63 & Vine	26	Belmont
23	Haddington-Haverford	27	Haddington-Hestonville
18	Lancaster-Haddington	28	Overbrook
88	Lancaster-Haddington Subway	19	Baring
		89	Baring Subway

Two of these lines run through the delivery district east and west on Arch Street, one runs on Arch east of 9th Street; four run on Market Street to the ferries, and two enter the subway.

It is suggested that this district be served by the following 8 lines: (See Map No. 18)

SUGGESTED LINES

Number	Name	Number	Name
118	Lancaster-Chestnut	119	Baring
124	Lansdowne-Market	123	Haverford-Arch
188	Lancaster Subway	128	Overbrook
189	Baring Subway	126	Belmont

Two of these lines run east and west through the delivery district on Arch Street; one is located on Market Street to the ferries; one on Chestnut & Walnut Streets; one runs on Chestnut & Walnut Streets east of 8th Street, and two enter the subway.

Changes in individual lines, and the reasons therefor, are as follows:

The Haverford Avenue line (No. 123), is routed into the delivery district on Arch Street instead of Market in order to give Arch Street a wider range of destination in West Philadelphia. Haverford Avenue is comparatively close to Market Street and if the new crosstown line on 46th Street is built, people along Haverford Avenue will have ample facilities for reaching points on Market Street by way of the subway-elevated. The Haverford Avenue line also is routed in both directions on Vine Street west of 52nd in order to divide the territory between Girard Avenue and Market Street.

The Market Street surface line (No. 124), is carried east to City Hall only, as passengers going east of this point are sufficiently served by the subway-elevated.

The Lancaster Avenue surface line is routed east and west through the delivery district on Chestnut and Walnut Streets (No. 118). This gives to the northern part of West Philadelphia a line on Chestnut and Walnut Streets, and also provides these streets with direct service to the West Philadelphia station of the Pennsylvania Railroad.

A suggestion is made for straightening the Baring Street line by locating it on 33rd Street, Fairmount Avenue and 40th Streets (No. 119).

West Philadelphia—Market Street, South

At present there are 8 lines leading from West Philadelphia—Market St. South, to the delivery district as follows: (See Map No. 17)

EXISTING LINES

Number	Name	Number	Name
9	Chestnut	12	Darby
25	West Spruce	86	Darby Subway
13	Baltimore	14	Gray's Ferry
87	Baltimore Subway	16	Elmwood

Four of these lines run east and west through the delivery district on Chestnut & Walnut Streets; two enter the Market Street subway; one runs across the delivery district on 9th and 12th Streets, and one runs along the south boundary of the delivery district entering it near the Delaware River.

It is suggested that this district be served by the following 9 lines: (See Map No. 20)

SUGGESTED LINES

Number	Name	Number	Name
109	Chester Ave.-Market	112	Darby
109½	Chestnut St. (tripper line)	186	Darby Subway
125	West Spruce	114	Gray's Ferry
113	Baltimore	116	Elmwood
187	Baltimore Subway		

Two of these lines run east and west through the delivery district one on Market Street and one on Chestnut and Walnut Streets; two run as far east as 10th Street on Chestnut and Walnut Streets; one runs on Market Street to the ferries; two enter the Market Street subway; one runs across the delivery district on 11th and 12th Streets, and the Gray's Ferry line on Spruce & Pine Streets to Dock Street is unchanged.

Changes in individual lines, and the reasons therefor, are as follows:

The Chester Avenue line (No. 109), is extended direct to Woodland Avenue and thence east on Market Street to the ferries, the Baltimore Avenue surface (No. 113), line is diverted to Chestnut Street on 46th Street. This gives Chester Avenue a quick route into the delivery district. The diversion of the Baltimore Avenue surface line at 46th Street gives Baltimore Avenue a wider range of destination, and is not objectionable on the score of speed, as this avenue has a direct line into the subway.

The West Spruce line is continued east on Spruce Street to Woodland, and thence to Chestnut and Walnut Streets (No. 125). It would probably be desirable at the rush-hour to supplement the service on Chestnut Street by a tripper line (No. 109½), line running as far as 46th Street.

In West Philadelphia the crosstown problem is much more difficult on account of the street layout and of the location of the present lines and elevated railway stations.

At present there are 7 crosstown lines serving West Philadelphia as follows: (See Map No. 21)

EXISTING LINES

Number	Name	Number	Name
10	Chester Ave.	22	Bala
11	Chester Ave. extension	30	58 & 60
21	Lombard & South	31	Zoo
15	52 St.		

Three of these lines are plain crosstown lines; two extend southwesterly from 40th & Market Streets; one runs north and south on or near 40th and turns east across South Philadelphia; and the Zoo line is a short loop.

It is suggested that this district be served by the following 8 lines: (See Map No. 22)

Suggested Lines

Number	Name	Number	Name
110	Chester Ave.	130	Overbrook-60 St.
111	Chester Ave. extension	121	Lombard & South
115	52 St.	142	Beach & University
122	Bala	196	46 & 49

Changes in individual lines, and the reasons therefor, are as follows:

The function of the present 52nd Street and 58th and 60th Street lines is largely to distribute the subway-elevated traffic. They are about seven-eights of a mile apart at Market Street. The 52nd Street line is operated at 4 minutes basic headway and 2.5 minutes rush-hour headway, and the 58th and 60th Streets line at 4 and 2.1 minutes respectively. The former transferred 8,262 passengers to the subway-elevated on the day of the riding count, and the latter 5,237. If a line were built between, on 56th Street, the average walk, or one-half the distance between lines plus one-quarter the length of a block, would be about 1,300 ft. as against about 2,300 ft. at present. The traffic at present will hardly support a line between, but when it grows sufficiently to do so, the new line on 56th Street should be connected to the present track on 58th Street from Baltimore to Woodland Avenue, and the present 60th Street track should be carried west on Baltimore Avenue to the end of the line (No. 130).

Between Haverford and Lancaster Avenues, at 48th Street, is a diamond-shaped area two-thirds of a mile wide, by about one mile long, which has no street car line, although it is entirely built up. The maximum walk in this area is about 2,000 feet, which is greater than in any other similarly built up area in the city. It could be accommodated by an east and west line running into the delivery district or by a crosstown line on 46th Street connecting with the subway-elevated. The latter is considered preferable, as it tends to load the subway-elevated instead of the surface system and would provide quicker service. Moreover, the east and west streets in this area are not conveniently located. This 46th Street line should be connected with the present track on 49th Street and the present 52nd Street line should ultimately be extended southwesterly between Chester and Baltimore Avenues. A crosstown line on 46th Street might run on Lancaster Avenue from 46th Street to Girard Avenue, or might step over to Belmont Avenue, at Lancaster and continue to the Park (No. 196). The latter route would be preferable whenever connection is made with 49th Street on the south.

The Chester Avenue lines which transfer to the subway-elevated, are located as at present (No. 110 and 111).

Both tracks of the Lombard and South line are shown on Spruce and 40th Streets (No. 121).

The connection of a part of the present Zoo line (No. 142), with the present Beach Street line is also shown with the West Philadelphia crosstown routes.

No changes of importance are suggested in lines not herein mentioned.

Crosstown Lines in South Philadelphia

At present there are 7 crosstown lines in South Philadelphia: (See Map No. 15)

Existing Lines

Number	Name	Number	Name
14	Gray's Ferry	7	Catharine & Bainbridge
16	Elmwood	8	Federal & Wharton
21	Lombard & South	39	Morris & Tasker
6	Point Breeze		

These lines furnish adequate east and west service north of Morris Street, except that the Federal & Wharton line should be extended westward. One line extends to the northwest; one to West Philadelphia and two to Darby and vicinity.

It is suggested that this district be served by the following 8 lines: (See Map No. 16)

Suggested Lines

Number	Name	Number	Name
114	Gray's Ferry	107	Catharine & Bainbridge
116	Elmwood	108	Federal & Wharton
121	Lombard & South	139	Morris & Tasker
106	Point Breeze	193	2 & 3-Snyder

These suggested lines are in general the same as the present lines, but include a line on Snyder Avenue connected with the line on North 2nd and 3rd Streets.

Changes in individual lines not elsewhere included, and the reasons therefor, are as follows:

The Federal and Wharton line (No. 108), is extended west to 34th Street on Reed and Wharton Streets.

The Elmwood line (No. 116), is shown running east on Christian Street instead of Spruce and Pine Streets, and north across the delivery district on 11th and 12th Streets instead of 9th and 12th Streets. The change to Christian Street will accommodate some of the traffic which at present transfers to the east by the Federal and Wharton line, and it will also furnish a quick route from South Philadelphia to West Philadelphia by way of 49th Street.

Snyder line (No. 193), is as described above.

The Gray's Ferry, Lombard & South, Point Breeze, Catharine & Bainbridge and Morris & Tasker lines are unchanged in this part of the city.

Crosstown Lines in North and Northeast Philadelphia

At present there are 11 crosstown lines serving North and Northeast Philadelphia, as follows: (See Map No. 11).

Existing Lines

umber	Name	Number	Name
29	Race & Vine	43	York & Dauphin
40	Callowhill	68	Lehigh
42	Beach	79	Allegheny
20	Girard-Belmont	80	Allegheny Short Line
76	Girard	70	Erie
77	Jefferson		

Between the Jefferson and York & Dauphin lines crosstown service from 33rd Street to 7th Street is furnished by the Columbia Avenue line. These lines furnish adequate east and west service between the rivers. One line runs from the northeast to the west central and two from the northeast to West Philadelphia.

It is suggested that this district be served by the following 9 lines: (See Map No. 12).

SUGGESTED LINES

Number	Name	Number	Name
142	Beach & University	197	Wayne-Somerset-Lehigh
176	Girard	179	Allegheny
177	Jefferson & Master	180	Allegheny Short Line
143	York & Dauphin	170	Erie
168	Lehigh		

These lines provide substantially the same facilities as the present system, with the addition of a line from the northeast to Germantown, and one from the vicinity of Port Richmond to the University of Pennsylvania.

Changes suggested in individual lines and the reasons therefor, are as follows:

It is suggested that the present Beach Street line which runs east and west on Green Street and Fairmount Avenue be carried west across the Spring Garden Street bridge and combined with a part of the present Zoo line (No. 142). The Beach Street line barely earns operating expenses, and the Zoo line is a poor makeshift. The combination would give a connection between the Spring Garden district and important points in West Philadelphia, such as the University of Pennsylvania and the West Philadelphia Station of the Pennsylvania Railroad.

The present Girard Avenue line (No. 176) from Allegheny to 63rd Street is not changed.

The northern end of the Jefferson and Master Streets line is extremely crooked and indirect. It is suggested that this end be changed to run on Frankford Avenue as far north as Allegheny Avenue and west on Columbia and Oxford to 10th and 11th Streets, thence south to Jefferson and Master Streets (No. 177).

In order to divide more evenly the territory between Columbia and Lehigh Avenues, the York and Dauphin line is located on Dauphin and Susquehanna to 22nd Street, and thence west on York and Dauphin (No. 143).

It is suggested that the Glenside line terminate at the North Philadelphia Station and that two lines be operated on Lehigh Avenue; one (No. 168) running as at present, and the other using the Somerset Street track of the present Jefferson and Master line east of Kensington Avenue (No. 197). This new line would turn north on 17th Street and would run out Wayne Avenue to Chelten Avenue.

The Allegheny Avenue line is shown as at present (No. 179). When Allegheny Avenue is opened between 17th and 22d streets it is possible that all or part of the service should be run straight across Allegheny Avenue, avoiding the present detour to Lehigh Avenue (No. 180). This offset, however, serves several minor traffic points. The traffic count shows that about 840 of the passengers on this line ride in each direction daily all the way around the present detour, and that 520 travel to points on the offset.

The Erie Avenue line (No. 170) is not changed from the present, although as this line transfers a large number of passengers to 2nd and Front Streets, a connection with one of the north and south lines may at some future time be desirable.

No lines are shown on Callowhill Street. If it is not considered desirable to abandon this street, the present route may be continued, although it does not carry enough passengers to pay operating expenses.

Routes in the Delivery District

To study the utilization of the delivery district trackage and the comparative delivery facilities afforded the various lines and sections of the city, diagrams of all the routes in the delivery district, as existing at June 30, 1910, and as suggested, have been prepared (Maps Nos. 29 and 30). On that of existing routes it is noticeable that, while the most important part of the district is between 7th and 15th Streets, there are few routes on the north and south streets between 10th and 15th streets, and the maximum use of Market and Arch Streets is east of 7th Street. The suggested system provides twenty north and south routes (counting both directions) between 9th Street and City Hall, as compared with fourteen existing, and the maximum use of the east and west streets is between 6th and 11th Streets. On the diagrams showing lines on each of the east and west delivery district streets, only the lines running on these streets for more than one block are shown.

Market Street

At June 30, 1910, six lines, not including subway lines, used Market Street east of 17th Street, one running to the northwest, one to the southwest, and four to the northerly part of West Philadelphia.

Nine suggested lines are routed on Market Street, three spreading to the north, three to South Philadelphia, and three to West Philadelphia, the latter being located on Chester Avenue, Market Street, and through the territory of the present Baring Street line. These lines are so located that with the present schedules the maximum number of cars passing any point per hour would be 122, as compared with 111 by the present routing.

Arch Street

Under the existing plan twelve lines are routed on Arch Street, one running to the north central district, six to the northwest, one to the south central, one to the southern part of West Philadelphia and three to the northern part of West Philadelphia.

Eight suggested lines are located on Arch Street, one running to the northeast, three to the northwest, one to the south central, one to the southwest and two to the northern part of West Philadelphia. The maximum number of cars per hour passing any point would be, under schedules of June 30, 1910, 114 with suggested routes as compared with 124 with present routes.

It is suggested that the Arch Street tracks be extended south on Front Street to a terminus at or near Market Street, to provide better facilities for reaching the Market Street ferries. In making this extension, the tracks should be located on the east side of Front Street alongside the Company's property.

Chestnut and Walnut Streets

At June 30, 1910, nine routes were operated on Chestnut and Walnut Streets east of 17th Street, four running to the northwest, one to the southwest and four to the southern part of West Philadelphia.

Eleven suggested routes or ends of routes are located on these streets, two running to the north central, two to the northwest, one to the southeast, one to the southwest, two to the northern part of West Philadelphia, and four to the southern part of West Philadelphia. These routes are so located that with existing schedules there would be a maximum of 111 cars per hour, as compared with 139 operated at June 30, 1910.

New Track Required and Present Track Abandoned

The suggested routing system would require the construction of about 33 miles of new track, and would permit the abandonment of about 27 miles of existing track, making a net addition of about 6 miles, single track measurement. Of the new track about 9 miles is in extension of existing track, 5 miles being in South Philadelphia. If the suggested plan is adopted, the changes in most cases could preferably be made when the existing track wears out.

As fewer transfers and exchanges would be required with the suggested routes, a rearrangement of the transfer and exchange system would become necessary.

Rapid Transit

That Philadelphia, the third city in size in the United States, has maintained its rate of growth without a distinct rapid transit system, is due to the large self-centered manufacturing districts and the favorable arrangement of the steam railroad lines. These lines spread through the entire northern and western portions of the city with frequent stations, and terminate at the very heart of the delivery district. There are certain important areas and lines of travel, however, not served by railroad passenger lines. The steam railroads cannot gather travel by crosstown branches, and their terminal facilities are already over-taxed. From the standpoint of the general public, the steam railroad service does not provide frequent and uniform headways between trains, and does not afford general inter-district communication.

The present subway-elevated system serves one of the large districts not served by steam railroad lines. Other similar districts where the need appears to be equally as great are in the northwest along Ridge Avenue; in the northeast and to some extent in South Philadelphia. If a general system is designed, however, the fact must not be overlooked that such means of transit and the increasing height of buildings will tend to congest the narrow streets in the delivery district to a point where the streets themselves will become the impeding factor in city development. The layout of a high-speed passenger system which will best accommodate the traffic, and which will be commercially practicable is a complicated problem, and should be made only after the fullest investigation and study.